A GUIDE

TO

PHOTOGRAPHY,

CONTAINING SIMPLE AND CONCISE DIRECTIONS FOR OBTAINING

Views, Portraits, &c.,

BY THE ACTION OF LIGHT ON PREPARED SURFACES OF

PAPER, GLASS, AND METAL,

INCLUDING THE

CALOTYPE, DAGUERREOTYPE,

AND THE IMPROVED PROCESSES WITH

COLLODION, ALBUMEN, AND WAXED PAPER.

BY

W. H. THORNTHWAITE,

AUTHOR OF "PHOTOGENIC MANIPULATION," ETC.

Fifth Edition.

GREAT EXHIBITION PRIZE MEDAL

FOR

PHOTOGRAPHIC APPARATUS.

HORNE, THORNTHWAITE, AND WOOD,

121 & 123, NEWGATE STREET, LONDON.

1852.

Francis Bedford.

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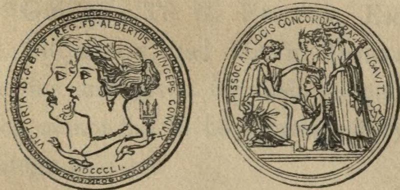

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PREFACE

TO THE FIFTH EDITION.

In the present edition I have endeavoured, as far as possible, to give only one, and that the best and most practicable method for each of the various processes for obtaining pictures by the agency of light. This course I have adopted, in preference to giving a multitude of methods of manipulation and proportions of chemical mixtures, which, however interesting they might have been to the well-versed in the subject, was thought more likely to bewilder the beginner than prove a "Guide." To R. Fenton, Esq., Messrs. Ross and Thompson, and Mr. F. Horne, my best thanks are due and given for their valuable contributions, which cannot fail to be appreciated by all lovers of the photographic art.

W. H. THORNTHWAITE.

August, 1852.

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ON

PHOTOGRAPHY AND DAGUERREOTYPE.

BY W. H. THORNTHWAITE,

AUTHOR OF "PHOTOGRAPHIC MANIPULATION,"

ETC., ETC., ETC.

INTRODUCTORY REMARKS.

THE art of making sun-pictures, whether on paper or films of various kinds, or silver plates—may be designated under the general term photography—a term derived, as is well known, from the two Greek words *phōs*, "light," and *graphō*, "I write or delineate," and includes various specific operations to which the appellations Calotype, Talbotype, Daguerreotype, and Photography, have, at different periods and on various occasions, been given. All these operations will be treated of in detail; such as concern the depiction of forms on paper and tissues first coming under consideration, and on metals afterwards. But, as a preliminary to both, it will be necessary that we should acquire a true idea of the nature and properties of light.

Of the ultimate constitution of light we positively know no more at the present day than did Plato, Pythagoras, or Aristotle; but the assiduous efforts of philosophers since, by the prosecution of inductive philosophy, have made us well acquainted with many of its physical and chemical qualities.

Two leading theories, more or less developed, have existed since the days of Pythagoras—at least in relation to the nature of light. According to the one theory it was assumed to be composed of wavy oscillations in some ill-understood medium, which was supposed to fill all space; according to the other, it was a congeries of actual physical emanations from luminous bodies—emanations which were assumed to be so far material that hopes were entertained of the possibility of weighing them, by balances of an exceedingly delicate make. The first is called the undulatory, the second the corpuscular, theory of light. Now, the undulatory theory of light, although adopted by many of the ancients, only assumed consistent shape in the days of Huyghens, who was born a few years before Newton; and, so far as England is concerned, is a theory of very modern adoption; for Newton was violently opposed to the undulatory or wave theory of light, and the prestige of his great name caused it to remain in abeyance until the early part of the present century, when the discovery of polarized light, and the investigation of the laws of double refraction, made known many phenomena which were totally irreconcilable with the Newtonian theory, although easily explicable by the theory of undulation. Hence the latter gained new force, and at the present day may be said to be universally adopted.

We need not carry this description further; for all our future purposes, the operation of light—not its ultimate nature—will alone have to be treated of. Now, the operation of light is either optical or chemical. As an optical agent, its properties all depend on the property it has of acting in straight lines, thus giving rise to the idea of a ray; as a chemical agent, our knowledge is bounded by the mere cognisance and expression of certain facts, concerning the ultimate rationale of which we are completely in the dark.

As I shall presently have to treat of rays of light, it is necessary at once to say, that the term is merely conventional. If light be composed of undulations or waves, as we assume to be the case, then it is clear there can really be no such things as rays; but, although light may consist of waves, it is not difficult to conceive the action of those waves to be in the direction of a straight line; and this straight line is to be considered as a ray.

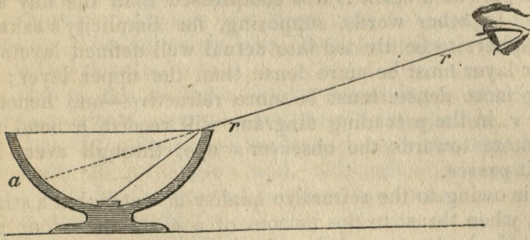
The two most prominent optical qualities of light are reflection and refraction, of which the latter more narrowly concerns us, inasmuch as upon a true comprehension of its nature depends the right understanding of the whole theory of lenses.

Although light has been said to act in straight lines, the proposition only holds good for one homogeneous medium. Whenever two media of different densities come in contact, we have immediately an indication that light may be deflected—*refracted*, as it is called, from the straight line.

There are many satisfactory experiments for demonstrating this effect; one, and a very pretty one, is as follows:—

Suppose the accompanying diagram to represent a basin, in which is placed a small object, say a coin. Now, the conditions being such, and an observer being placed, as re-

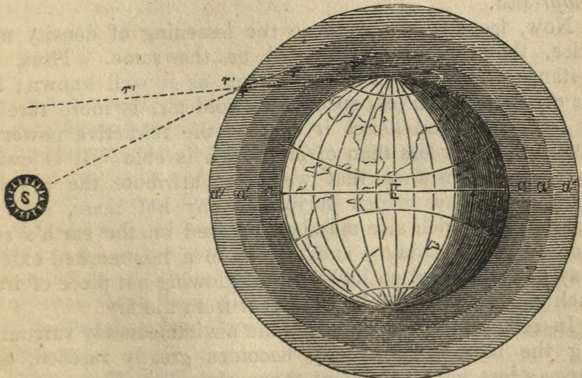
Fig. 1.



presented by the eye, the coin will be invisible, because the ray of light, *r r*, will impinge on the side of the basin, *a*. If, however, water be now poured into the basin, all other conditions remaining exactly the same, the coin will be made visible; simply because the water has the property of bending or refracting from its original direction the ray *r r*, and causing it to impinge in the direction of the even line.

Again, it is owing to the same operation of refraction, but through a different medium, that we see the sun after that luminary has descended below the level of the horizon:—

Fig. 2.



The earth, as is well known, is surrounded by an atmosphere, extending some forty-five miles high; and it is evident that the upper part of the atmosphere must be less compressed than the lower part—just as the hay in the upper part of a stack is less compressed than the hay at its base. In other words, supposing, for simplicity's sake, the atmosphere to be divided into actual well-defined layers, the under layer must be more dense than the upper layer; and, being more dense, must be more refractive—and hence the ray *r r*, in the preceding diagram, will receive a bend more and more towards the observer's eye, through every layer that it passes.

It is owing to the refractive quality of water that a straight stick, when thrust to the bottom of a clear stream or pond, always looks bent; and that the locality of all objects lying at the bottom of vessels of water is so deceptive to the eye. It is owing to the same quality, also, that none of the heavenly bodies, except such as are directly over the observer's head, are ever seen in their true position; for the same refractive agency which enables us to observe the sun when he has already sunk below the horizon, would also enable us to see a star, or, in short, any other luminous body, as under similar conditions.

I have already said that the upper portions of the atmosphere are less refractive than the lower portions, because they are less dense, and that they are less dense because less *compressed.*

Now, from whatever cause the lessening of density may arise, the effect on light will be the same. Thus, for instance, heat is an expansive agent, as is well known; hot air occupies much less space than cold air, is more rarefied or *less dense;* and hence it is, that the refractive power of hot air is much less than of air which is cold. It is owing to this circumstance that we must attribute the peculiar wavy appearance which surrounds any hot mass, such as a lime-kiln, which also may be observed on the earth's surface on very hot days; and which, to a less marked extent, may be recognized on looking at a glowing hot piece of iron, such as a poker taken incandescent from the fire.

In either of these instances the air immediately surrounding the incandescent body becomes greatly rarefied, and hence a less refractive agent than originally. Two media of different densities, in fact, are presented to the rays of light which proceed from the object to the eye; and hence it is that these rays are bent, giving rise to a halo-like confusion, or mixing of light all round the heated body.

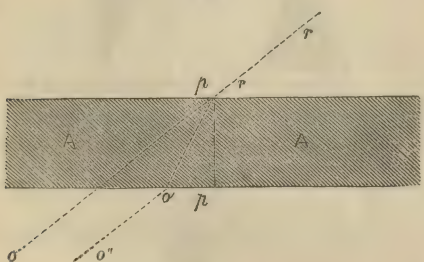
Many other familiar illustrations of the property of refraction might be adduced, but these will be enough for my purposes. The following laws, then, as regards refraction may be laid down:—

1. That a ray of light, whilst traversing a medium of unvarying density, never departs from a straight line.

2. That, if the density of medium changes, the ray of light turns away at an angle; and, although still pursuing a straight line, for the present medium, is crooked as regards the line already traced.

3. That a ray of light, passing from a rarer to a denser medium, bends towards the perpendicular of the surface of the latter, and *vice versa*, thus:—

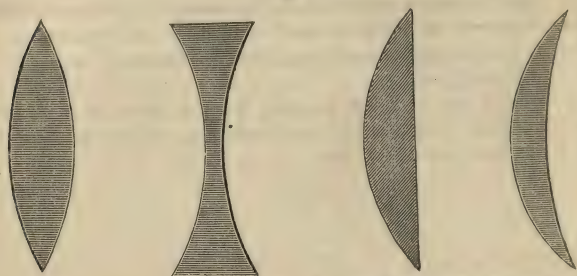
Fig. 3.



A is a block of glass, on which the ray of light *r r* falls; the air through which it has traversed is the rarer medium in comparison with the glass; hence, in virtue of the third law, the ray does not go straight on to *o*, but is refracted towards the perpendicular *p*. in the direction *o*′, and, emerging into the air, proceeds to the point *o*″. This rule, simple though it be, is the very groundwork and foundation of the whole theory of lenses. Under one circumstance, however, there would have been no bending of the ray, namely, if it had impinged perpendicularly to the refractive material's surface.

A lens is a curvilinear segment of glass, or other transparent material, used for the purpose of effecting certain refractive distributions of rays of light. Lenses are of various shapes; thus we have the convex, concave, and plano-convex lenses; there is also the meniscus lens, which is shaped like a crescent; of which we will select the first for the purpose of demonstrating how simply the agency of lenses is comprehended by reference to the law of refraction. Now, the convex lens, which I propose to investigate, may clearly be regarded as an assemblage of many small facets or planes;

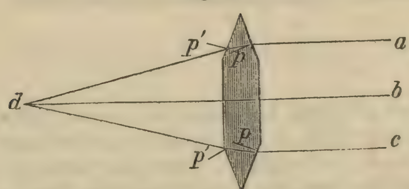
Fig. 4.



Convex. Concave. Plano-convex, and Meniscus lenses.

and, reducing the case to its simplest expression, we may assume each surface to be composed of three facets, thus:—

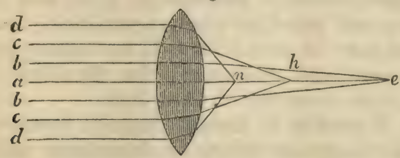
Fig. 5.



Now, let us examine what should be the result, according to the laws of refraction, already laid down on the rays of light, *a b c*, permitted to fall upon our representative of a double convex lens. In the first place, it is clear that the middle ray *b*, should not be refracted at all; it should go straight on, because it falls on the middle facet of the lens perpendicularly to its surface. But, as for the other rays, they fall respectively on their corresponding facets, each at an angle. Hence, if the law already laid down be true, they should be refracted or bent towards the point *d*, which we find to be the case.

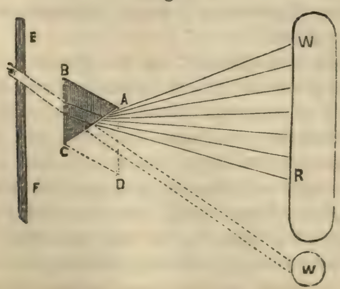
It is found in practice that, even if the light with which we operate be monochromatic or one-coloured light—still all lenses which are made out of sections of spheres do not cause the rays to converge to an *exact* focus; but only yield an approximation to this result, as is indicated by the accompanying diagram, from a consideration of which it will be seen, that the rays which pass through the edges of the lenses are the most refracted of the lot,—are those which most widely wander from the desired focus or point.

Fig. 6.



Now this scattering of *one-coloured* rays, by lenses cut out of spherical forms, is called *spherical* aberration. The learned Descartes devoted himself to an investigation of the reason of this spherical aberration; and eventually he succeeded in calculating the proper oval out of which lenses should be cut, so as to refract one-coloured light to a perfect focus. In practice, however, the additional trouble of making lenses out of these Cartesian ovals was found not worth the pains;

Fig. 7.



because, although they succeeded in correcting mere spherical aberration of one-coloured light, yet, whenever white or coloured light came to be operated upon, another difficulty sprung up in the form of what is called *chromatic* aberration.

It was said by Newton,—and the expression was very generally employed up to our own days,—that white light might be decomposed into seven primitive colours—*red*, *orange*, *yellow*, *green*, *blue*, *indigo*, and *violet*, as indicated by the foregoing diagram. (*Fig.* 7.)

It is not a little strange that Newton should have failed to discover the now well-known fact to us, that the prismatic spectrum does not present us with seven, but with only three, primitive colours—*red*, *yellow*, and *blue*:—which, by being combined amongst themselves, give rise to green, orange, indigo, and violet, as their secondaries. Such, however, was the fact; a sort of mystic reverence attached to the number seven, and it remained for Sir David Brewster to prove the triple character of white light.

Chromatic aberration of lenses naturally flows out of the property of a triangular prism to decompose white light. The edges of a lens, especially a convex lens, are only prisms, and hence they must naturally produce a prismatic decomposition of light.

The two aberrations—namely, spherical and chromatic, are the two great difficulties which optical instrument-makers have to encounter; nevertheless, by taking advantage of certain facts, and by proceeding with care, they may be, by a series of compensations, almost entirely overcome. Now, this conquering of spherical and chromatic aberration in optical instruments is really a great achievement, when we consider that the illustrious Newton pronounced the task, in his opinion, hopeless.

I do not think it necessary, on the present occasion, to go minutely into the means which opticians have recourse to for the overcoming of spherical and chromatic aberration. A few general remarks on these subjects will be all that I shall here make, reserving a more detailed account when treating of the various forms of photographic lenses.

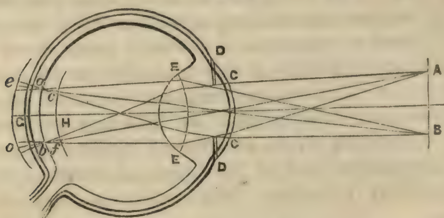
In the first place, then, it will be observed, by reference to preceding diagrams, that, so far as the error of chromatic aberration is concerned, it resides chiefly in the edges of a lens; hence the most natural suggestion arises, of cutting off these rays altogether by means of a curtain or diaphragm, and this is one of our most frequent resources. But what we gain in correctness by these, we lose in illumination; hence it is desirable to place one's self beyond the necessity of using diaphrams whenever practicable. I must here remark that the curtain or stop is not only useful in lessening chromatic but also spherical aberration; indeed, so far as remedial resources are concerned, little distinction may be made between the two. The next great means of lessening these two aberrations consists in availing ourselves of a property not known to Newton, otherwise he would never have spoken so despondingly concerning the manufacture of achromatic instruments. It is this—that different kinds of glass have different powers of refrangibility on the same coloured light, and thus, by making a lens of different kinds of glass, in the required proportions and of the required curves, we can almost completely overcome both spherical and chromatic aberration.

I cannot leave the subjects of spherical and chromatic aberration without alluding to the beautifully efficient methods nature has had recourse to for overcoming these difficulties in the eyes of animals. I speak now of the eyes of man, and other mammalia; for, on descending into the lower orders of animal life, the structure of the eye becomes far more simple than any one except a naturalist would imagine.

From what we have said of chromatic aberration, it is quite evident that, were it not completely overcome by adequate provision in the human eye, we could never have seen a white object; or rather, we could never have seen it in its true colour of white. Its edges would be surrounded with a halo of iridescent light; and every attempt at truthful observance of colour would have been fruitless. Now, I need scarcely say that the difficulty has been so completely overcome, that, notwithstanding all the long list of diseases to which the eyes of human beings and animals are subject, chromatic aberration is of the rarest possible occurrence.

So completely like an optician has nature set to work in her fabrication of eyes that, even after my curtailed account of the means had recourse to by opticians for overcoming the chromatic difficulty, the rationale of the structure of the eye will be evident on viewing a sectional diagram of its structure, without the necessity of an explanation. Still, however, to be precise, the various provisions of nature are these:—First of all, on taking a general survey of the ocular structure, we find it to consist of a collection of different transparent media of various densities, of different curves, different refrangible properties; we have in the iris a contrivance which is the precise counterpart of the black stop or curtain used by opticians for cutting off external rays; and carrying our

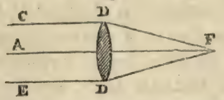
Fig. 8.



examination more closely, we find that the various humours or lenses, instead of being strictly spherical, are constructed out of curves more proper for avoiding aberration. And, not content with adopting the adjuncts of Cartesian curves, compound lenses, and the optician's stop, nature has gone farther still, and, in the beautiful contrivance of an enlarging and decreasing aperture which we find in her iris or stop, she employs a mechanism so wonderfully refined that man would vainly endeavour to adopt it for his optical instruments. With regard to the iris of eyes, I may observe that the general notion of its use is merely as a means of cutting off an excess of light, and thus tempering the vision to the varieties of illumination to which it is exposed. Undoubtedly this is one use of the iris and its moveable pupil, and indeed its greatest use; but, collaterally, it also acts as one means in nature's optical economy of preventing any chance of spherical and chromatic aberration.

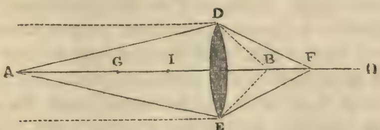
Before proceeding to explain the peculiarities of that portion of a ray of light which produces the greatest photographic or chemical effect, I would point out some of the necessary consequences resulting from that principle of refraction already explained, more particularly with respect to the formation of images or representations of natural objects by means of lenses. When a convex lens is directed towards a luminous object placed at an infinite distance, as the sun for instance, a bright and luminous spot will be observed on a piece of paper held at a certain distance behind the lens. Now, this spot is called the principal *focus*, or focus of parallel rays of the lens; and its distance from the lens the focal length, which depends upon the convexity of the lens; the greater the amount of convexity the shorter the focus. In the accompanying figure D D may represent a lens and C A E parallel rays of light, which, on passing the lens, will be refracted, and, by meeting, form a focus at F.

Fig. 9.



Again, if the lens be directed towards an object, the rays from which are not parallel but divergent, as is the case with objects at a short distance, the focus F, or the point where the rays meet, will be at a greater distance from the lens, and a sheet of paper held at that point will show an *inverted image* of the object; and, if the distance of the object from the lens be made to vary, it will be found that the nearer it is to the lens the greater the distance the sheet of paper requires to be held behind the lens, to get a clear representation of the object, and *vice versa*. This will, perhaps, be better understood by reference to the following cut —

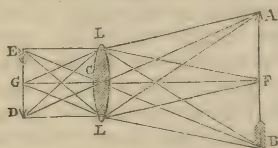
Fig. 10.



Let the dotted lines represent parallel rays of light falling on the lens D E, and refracted to the principal focus B, and and let A D, A E, be rays diverging from the point A, they will converge after passing the lens towards the point F, where they intersect each other, and form an image of the point A; and, if the lens be brought nearer to the radiating point A, the focus F will be lengthened, and *vice versa*. These alterations in the focal distance follow certain rules; for suppose the point A to be placed at G, a point equal to twice the principal focal distance C B, the focus F will be at H, as far behind the lens as the radiant point G is before it. If A be placed at I, the focus will be infinitely distant, or the refracted rays will become parallel, and will not form an image; finally, if A be placed between I and C, the rays diverge after refraction. Either of the points A or F may be considered as the focus, for, if the radiant point be F, its image will be formed at A, in the same way that A will produce an image or focus at F; it is to this relation or interchange between the radiant points and foci that the term has been given of *conjugate foci.*

The formation of images in that well-known instrument, the *camera obscura*, is due to a convex lens placed in the front of the instrument. It has been before mentioned that all images formed by a convex lens are reversed, and consequently inverted. Now, the reason of this, and also of the formation of an image, will be better understood by referring to the following cut:—

Fig. 11.



If A F B is an object placed before a convex lens, L L, every point of it will send forth rays in all directions; but for the sake of simplicity, suppose only three points to emanate rays, one at the top, one at the middle, and one at the bottom, the whole of the rays then that proceed from the point A, and fall on the lens L L, will be refracted and form an image somewhere on the line A C D, which is drawn direct through the centre of the lens; consequently the focus D, produced by the convergence of the rays proceeding from A, must form an image of A, only in a different relative position; the middle point of F, being in a direct line with the axis of the lens, will have its image formed on the axis G, and the rays proceeding from the point B will form an image as E; so that by imagining luminous objects to be made up of an infinite number of radiating points, and the rays from each individual point, although falling on the whole surface of the lens, to converge again and form a focus or representation of that point from which the rays first emerged, it will be very easy to comprehend how images are formed, and the cause of those images being reversed.

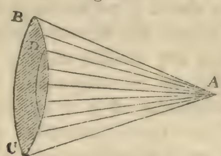
It must also be evident that in the two triangles, A C B and E C D, that E D, the length of the image must be to A B the length of the object, as C D, the distance of the image, is to C A the distance of the object from the lens.

This last rule will point out the method to be followed if images are required of a certain determinate size; for example, if C F was equal to C G, the image E D would be of the same size as the object A B; if C F was as long again as C G, the image would be half the size of the object; if, on the contrary, C F was half the length of C G, the image G D would be double the size of the object A B.

A knowledge of this principle is of some importance, inasmuch as the relative sizes of the image and object can be determined beforehand, and thus allowing more extended applications to be made of those instruments by means of which photographic pictures are obtained.

If two lenses be used of the same focus, the images produced by one may be rendered much more brilliant than those produced by the other, by having the former of larger diameter; for instance, if one of the lenses were two inches and the other one inch in diameter, the former would intercept four times the quantity of light more than the latter, and it is evident the image produced would be four times as brilliant; for example, the cone of light, A B C, in the

Fig. 12.



accompanying figure, would be entirely intercepted by the lens B C, while the lens D would only intercept a small part; so, when it is not possible to increase the brightness of the object by illuminating it, the brightness of the image can always be increased by using a larger lens.

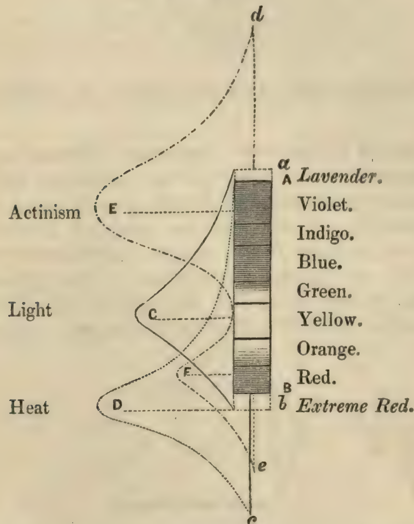
Care must be taken not to confound *brightness* with clearness; they are two things totally different, and the gaining of one does not in general depend upon the other; for it is necessary, in many cases, as before explained, when treating of spherical and chromatic aberration, to stop a portion of light from falling on the lens, by which means a much sharper picture is obtained.

When a ray of white light, as emanated by the sun, is decomposed by being passed through a prism, as before explained at fig. 7, into its primitive colours, it was discovered by Sir William Herschel that the different colours of the spectrum possessed different heating powers. This he ascertained by means of a number of thermometers which he placed at different parts of the spectrum, when he found that the heating power of the rays gradually increased from the violet, where it was the least, to the extreme red; and that the maximum temperature existed at some distance beyond the red, and out of the visible part of the spectrum. This discovery led to the inquiry, whether the chemical effect produced by light on some bodies, especially some of the compounds of silver, was due to the heat accompanying it, or to some other cause. This investigation has engaged the attention of several modern philosophers, among whom may be named Mr. R. Hunt and Sir J. F. W. Herschel, who have demonstrated that the chemical effects of light are not due to the heat present in the rays, but follow an entirely different law, being greatest at the violet end of the spectrum when the heating power is least, and least at the red when the heat is the greatest.

The fact is easily demonstrated by causing the prismatic spectrum to fall on a sheet of paper impregnated with chloride of silver, when the paper will become blackened at the violet end, and even beyond any visible rays of light, and the effect gradually decreasing as we approach the red. This and several other experiments of a like character have given rise to the idea that there must be some peculiar fluid accompanying light which produces all the chemical changes we notice are produced by light in our photographic experiments. The terms *energia* and *actinism* have each been proposed as a name for this supposed fluid; and, although both are open to the objection of not being sufficiently definite in their signification, the latter term, actinism, is the one now usually adopted.

Light may, therefore, be said to be made up of three separate and distinct fluids, producing actinic, luminous, and heating effects, and the relation of these to each other is shown in the following cut:—

Fig. 13.



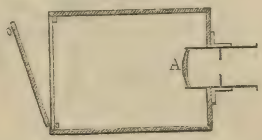
The shaded portion represents the colours as they occur in the decomposed solar beam; and the curved lines the relative amount of *actinism*, *light*, and *heat*, which in the case of Actinism is greatest at E, and ceases at *d* and *e*, having a slight increase, however, at F, which may be due, according to some experiments of M. Claudet, to the yellow rays, being not merely negative in their action, but having a positive destructive influence on the effects produced by actinic rays. Light is most intense at C, and ceases altogether at *a* and *b*; and Heat is greatest at D, disappearing at *a* and *c*.

From some very beautiful experiments of professor Stokes, and lately detailed by him in a paper read before the Royal Society, it would appear that different specimens of glass, although to all appearance equally transparent, do not allow the like amount of the actinic or photographic rays to pass through, and, therefore, the great Photographic power of some lenses over others may chiefly depend on the quality or kind of glass of which they are made.

PHOTOGRAPHIC APPARATUS, MATERIALS, &c.

The *Camera* is the most important piece of apparatus to the photographist, inasmuch as the clearness and sharpness of the results to be obtained mainly depend upon the accuracy of construction of the various parts. I shall therefore describe the various forms of this instrument usually constructed for *photographic* purposes. The simplest form of instrument which is at all applicable for photography is represented in section in the accompanying cut, and consists

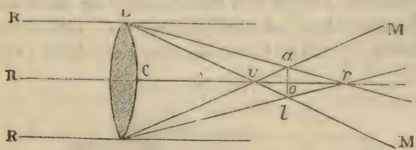
Fig. 14.



of a wooden box, in the front of which slides a brass tube holding a meniscus lens, A, having the radii of its curve in the proportion of two to one, and has also a diaphragm or stop placed a short distance in front of it; at the back of the camera slides a frame holding a piece of ground glass, for the purpose of ascertaining the focus, and also a frame so constructed that the prepared paper can be placed between a plate of glass and a smooth surface of wood or slate; in the front of the glass is a slide to protect the paper from the action of light till introduced into the camera. In using cameras which have either meniscus or plain lenses, it must be borne in mind that the visual focus, as shown on the ground glass, will not give a sharp photographic picture, and the reason of this is very obvious—for those rays which produce a chemical action on any sensitive surface or material always accompany the violet rays of the spectrum;

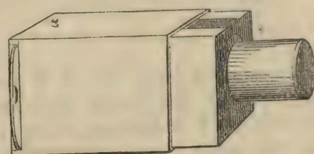
and, as the violet rays form a focus nearer to the lens than that requisite to give the best visual focus, the lens, therefore, must be approximated to the paper or prepared surface, so that it may be brought to that point where the violet and chemical rays form a focus. Although I have before explained the peculiarity of chromatic refraction, its application to the camera may be better understood by the following diagram:—

Fig. 15.



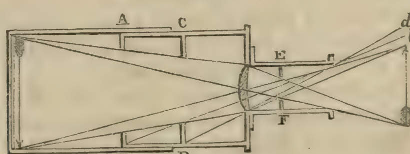
If L L be a double-convex lens, and R R parallel rays of white light, composed of the seven coloured rays, each having a different *index* of refraction, they cannot be refracted to one and the same point; the red rays being the least refrangible will be refracted to *r*, the violet rays being the most refrangible to *v;* the distance *v r* constitutes the chromatic aberration, and the circle, of which the diameter is *a l*, the place or point of mean refraction, and is called the circle of least aberration. If the rays of the sun are refracted by means of a lens, and the image received on a screen placed between C and *o*, so as to cut the cone L *a l* L, a luminous circle will be formed on the paper, only surrounded by a red border, because it is produced by a section of the cone L *a l* L, of which the external rays, L *a* L *l*, are red; if the screen be moved to the other side of *o*, the luminous circle will be bordered with violet, because it will be a section of the cone M *a*, M *l*, of which the exterior rays are violet. To avoid the influence of spherical aberration, and to render the phenomena of colouration more evident, let an opaque disk be placed over the central portion of the lens, so as to allow the rays only to pass which are at the edge of the glass, a violet image of the sun will be seen at *v*, red at *r*, and, finally, images of all the colours of the spectrum in the intermediate space; consequently, the general image will not only be confused, but clothed with prismatic colours. To obtain the clearest representation to the eye of any object placed before the lens C, the screen of ground glass must be placed at *a l;* but to produce a sharp photographic picture, the prepared paper must be placed nearer to the lens at V, or, what is equivalent, the lens adjusted nearer to the paper. The distance the paper ought to be approximated to the lens, after ascertaining the optical or visual focus, will depend, in a great measure, upon the focal length of lens, and the distance of the object. The best plan to arrive at this point is, to make one or two trials with the camera upon objects at different distances, and when the amount is once ascertained, mark the sliding tube. A modification of the foregoing has been suggested by Mr. Cundell, and is here represented.

Fig. 16.



The chief novelty in this arrangement is the introduction of two diaphragms within the body of the camera, and in the elongation of the brass front, both of which are useful in protecting the picture from all external light, except that which emanates from the objects to be copied.

Fig. 17.



By reference to Fig. 17, which shows this form of camera in section, it will be seen, that by means of the diaphragm, or "stop" E F, the rays from the barb of the arrow are excluded from the upper, and received only upon the lower half of the lens, at which they fall at a comparatively high and *equal* angle of incidence. They are thus less refracted than they would otherwise be, and their focus is not only sharpened, but elongated. By this means the picture, instead of being formed in the usual curve, is formed much nearer to a straight line in the plane of the prepared surface placed to receive it.

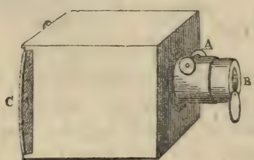
A lens of twelve inches focus, which is the kind most recommended, ought to have an aperture of 2·4 inches. The diaphragm at E F (in which the principal virtue of the instrument resides) should be placed 1·5 inch in advance of the lens, and its opening ought not to exceed 1·2 inch. By this arrangement a pretty sharp and distinct picture may be obtained about eight inches by six.

On the sliding part of the camera is placed a strip of wood or ivory, graduated for both the optical and chemical focus, so that the instrument can be set in an instant by merely measuring the distance of the object to be copied, if near, or by guessing at it, if out of reach.

The foregoing are the best forms of camera at present constructed with plain lenses; there is, however, another form of camera, which was patented by Mr. Beard, in which a concave reflector is employed to produce the picture, but which, being so small compared to the size of the apparatus, renders it of comparatively little use.

The only construction of camera which is calculated to produce the most finished and perfect photographs, is that in which an achromatic lens is employed. The achromatic lens is either single or compound; the single is usually employed for views, and the compound for portraits.

Fig. 18.



The usual form of camera, fitted with a single achromatic lens, is shown in the accompanying cut. It consists of a mahogany box, in the front of which is fixed a brass sliding tube A, having an achromatic lens at one end, and the opening contracted, so as to form a stop at the other, as shown at B. In the front of the stop is a small shutter, for opening or closing the aperture. At the back of the camera fits the ground glass for ascertaining the focus, and frame for holding the prepared plate or paper.

The reason why the single achromatic lens is usually employed for views and other inanimate objects is, that the time required to produce the picture is not limited, whereas, in the case of portraits, it is of great moment to obtain a result in the shortest possible time. This is accomplished by the employment of a combination of achromatic lenses.

Both Chevalier and Lerebours, in France, and Voigtlander, in Germany, have paid great attention to the construction of these compound lenses; and, till lately, were the only manufacturers who could supply a compound lens properly constructed. But now, in consequence of the great demand for the best description of lenses for photographic purposes, there has been great pains bestowed in England, both upon the manufacture of the glass of which the lenses are made, and also to ascertain the best curves, &c., to which they ought to be worked. The result has been the production of glasses, equal in every respect, and, in many instances, superior, to those imported from the continent, and at a much less cost.

Fig. 19.

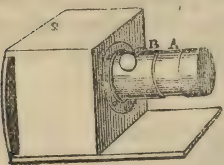
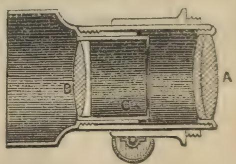


Fig. 20.



The above cuts represent a camera fitted with one of these compound lenses, and also an enlarged view in section, showing the disposition of the various lenses, &c., and, when properly constructed, will be found the most effective and useful lens for photographic purposes that can be obtained, as it forms either a short or long focus, as desired. It is furnished with a moveable brass cap D, and a series of stops or diaphragms C, which are employed when the lens is used for taking views, and sometimes portraits when the light is very brilliant.* When a long focus lens is required, as is

* The size of stop to be employed must be left to the judgment of the

usually the case for views, the back lens A is removed, and the whole of the brass mounting of the lens B is reversed, with respect to the camera, by its sliding tube, by which arrangement the convex surface of the lens B is placed within the camera, and is capable of being adjusted by the same rackwork as when the combination is employed.

Fig. 21.

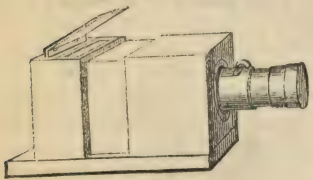
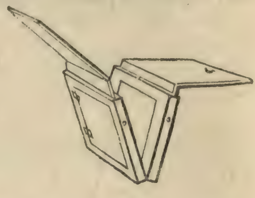
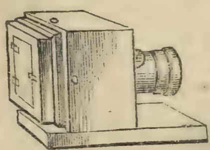


Fig. 22.



The most complete and convenient form of rigid camera is that represented in the above cut; it consists of two portions, one sliding within the other, by which either a long or short focus lens can be employed, and in the groove at the back is adapted either a frame for prepared silver or glass plates of various sizes, or one of Horne and Co.'s improved double frames, for holding two sheets of prepared paper in the space usually occupied for one, as shown at Fig. 22.

Fig. 23.

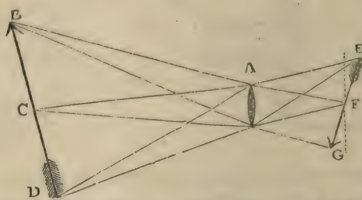


In some instances it is required to obtain representations of objects at a short distance from the camera, and whose position varies very considerably from a vertical plane, in which case the form of camera represented above is employed, which has a mechanical contrivance at the back,

operator, who will be guided by the time in which he desires the picture to be obtained, and also the character and arrangement of the objects to be represented; the smaller the stop the longer the time required, but the sharper and more distinct the picture.

whereby the relative position of the plate to the lens can be altered. This arrangement allows a lens of very short focus to be used, as the errors caused by various parts of the object to be copied being at different distances is, in great part, remedied by altering the parallelism of the back frame and the object-glass. This effect will be better understood by reference to the following diagram, Fig. 24, and what has been before explained relative to conjugate foci at page 11.

Fig. 24.



Let A represent the lens of camera placed opposite an object, B C D, in the position represented—it will be evident that the only point where a correct focus would be obtained on a vertical plane, represented by a dotted line, would be at F, but by shifting the position of the back to E, F, G, as shown in the cut, the whole of the object may be brought into focus.

Fig. 25

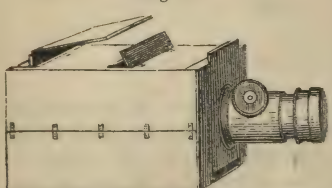
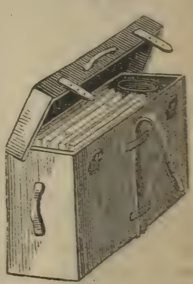


Fig. 26.



The most useful and complete camera for general photographic purposes, and especially adapted for tourists, from its extreme portability, combined with lightness and strength, is that represented ready for use at Fig. 25. The front of the camera holding the lens has a vertical adjustment, which enables the relative proportion of foreground, or sky, in the required picture, to be altered without disturbing the position of the camera. In the body of the camera is placed two or more openings or slides, by which either the long focus lens for views, or the shorter combination for portraits, &c., can be employed as desired. When not required for use, the lens is unscrewed, the front and slides lifted from their grooves, and the body of the camera folded together by the hinges, shown in the cut, by which arrangement the camera box, together with the slides for prepared paper, glass, or silver plates, frame for ground glass, achromatic lens, &c., can be conveniently packed, and in the smallest possible space, as shown in leather case at Fig. 26.

With the single achromatic lens, the focus is adjusted by rack-work, or by a simple sliding tube, but with the compound lenses, always the former; and as the achromatic glass, if properly constructed, causes all the coloured rays to meet at one focus, the correct adjustment will be that point where the object is represented in the clearest and sharpest manner on the ground glass. This is ascertained by throwing a piece of dark calico or other material, over the head and back of the camera, which, by shading the light, allows the picture to be seen on the ground glass; but by far the most correct method is by using a short conical tube, having a magnifying glass at its upper end, as represented at Fig. 27. The wide part is placed on the surface of the ground glass, and the eye, being placed at the other end, perceives a magnified representation of any required portion of the picture, by which means the requisite sharpness of outline is more easily and correctly obtained than by any other method.

Fig. 27.

Fig. 28.

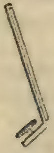
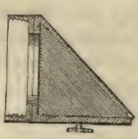
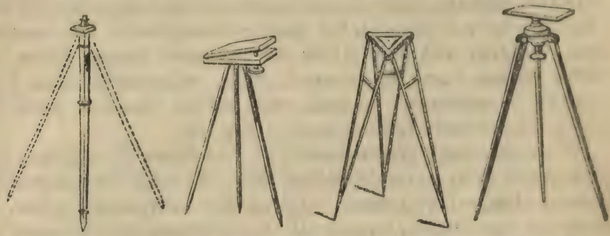


Fig. 29.



As all objects in the camera obscura appear reversed, that is, all right-hand objects will appear to the left in the picture, and *vice versa*, it is of great importance in the daguerreotype process to obtain the pictures as they appear in nature; this is accomplished by the small reflecting mirror or prism, Figs. 28 and 29, which have the effect of again reversing the object in the camera, and thus rendering the picture correct. When used, they must be turned towards the object to be copied, till a perfect representation is observed on the ground glass.

Fig. 30. Fig. 31. Fig. 32. Fig. 33.

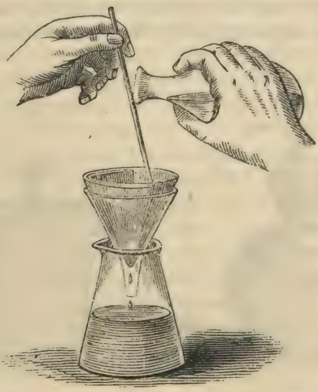


For the purpose of directing the camera towards the object to be copied, and keeping it steady during its employment, a variety of stands or supports have been contrived, the most convenient forms of which are represented above. Fig. 30 is constructed of three triangular legs, attached at the top to a brass ball and socket-joint, and which is adapted, when required, by a screw-plate to the bottom of the camera; it is a very portable stand, and answers its purpose remarkably well if the camera be of small dimensions; if required for a large sized instrument, the forms represented at Figs. 31, 32, and 33, will be found the best. Fig. 31 is of the simplest and cheapest construction of table stand, but is wanting in portability, and only possesses one adjustment for the purpose of altering the direction of the camera. Figs. 32 and 33 are the firmest and most convenient form of stands, possessing all the requisite adjustments; the former being best adapted, from its portability, for the use of tourists and travellers, the latter from its convenience for home use.

The various forms of apparatus, &c., which are required for specific photographic processes, will be best described when treating of these processes; but the photographist will find the commencement of his progress much facilitated, by possessing some few of those articles which are constantly being employed, and making himself familiar with their use, the chief of which are:—A pair of scales, the pans of which should be of glass, and a set of weights from 1 oz. to 1 grain; a graduated glass measure or two, to contain about 2 fluid ounces, and a smaller one, graduated into drops; and care should be taken that these glasses are perfectly smooth at the bottom, for the convenience of being cleaned out each time of using; and when measuring a quantity, the measure should be raised about level with the eye, by which the correct amount is easily determined; a few glass rods about 9 inches long, perfectly smooth and cylindrical, for the purpose of mixing and applying various solutions, and other purposes; a glass flask or two for making and heating solutions; a few glass funnels and conical-lipped glasses of various sizes for filtering solutions of silver, hyposulphite of soda, &c., and receiving the solutions when filtered. The arrangement for filtering is shown at Fig. 35.

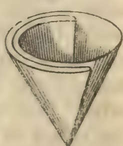
Fig. 34.

Fig. 35.



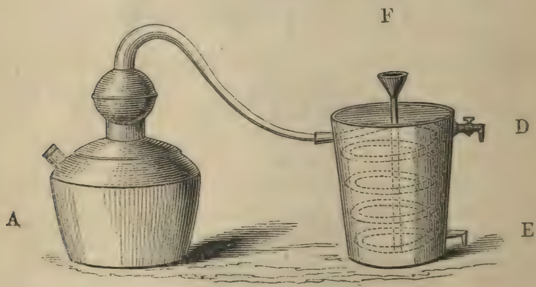
A funnel and receiving glass of the required sizes are arranged as shown in cut; a circular piece of filtering or bibulous paper is folded in half twice, so as to form, when opened, a kind of paper cone, as represented at Fig. 36; this is placed within the funnel, and the solution to be filtered, supposed to be in a flask, is poured in a gentle stream against the doubled side of the paper cone; this is best and most neatly performed by

Fig. 36.



applying a moistened glass rod to the edge of the vessel from which the fluid is to be poured, and placing the end of it so that a slight inclination of the flask or other vessel will cause a slender stream to flow down the rod against the side of the paper cone without the danger of breaking the paper, or spilling the fluid; a small spirit-lamp for heating solutions, and an oil or candle lamp, surrounded with a yellow or red glass shade, will be found extremely convenient, as affording sufficient light for manipulation, at the same time producing no sensible effect on any prepared surfaces of metal, glass, or paper. For the purpose of making the various solutions, distilled water should alone be used, and care must be taken not to employ distilled water containing the smallest quantity of any organic substances, such as essential oils, &c., which would speedily cause solutions of silver,—solutions chiefly used for photographic purposes—to become decomposed and useless. Where pure distilled water cannot be obtained, the requisite quantity can very easily be manufactured, by means of a portable still, represented by the accompanying cut.

Fig. 37.



The body A contains about a gallon of water, to be introduced through the opening, which is afterwards closed with a cork:—it is then placed over a gentle fire, and the worm-tub, placed on a convenient support, connected with it by means of an intermediate tube, the joints being rendered steam-tight by two short pieces of vulcanized India-rubber tube. The worm-tub being filled with cold water, condenses the steam as produced, and the distilled water runs off at the opening E. As the water becomes hot it is drawn off by the stopcock D, a fresh quantity of cold water being poured into it by the funnel F, which reaches to the bottom of the tub. A very pure water, and quite equal to distilled, can be obtained by melting a clean and clear piece of ice, the Wenham Lake ice being the best for the purpose.

The best substitute for pure water, and what is quite equal to it for many of the processes where a considerable quantity is required, as in washing out the salts of silver, &c., in preparing iodized paper, setting paper positives, &c., is made by boiling rain or soft river water, allowing it to cool, and then carefully filtering it.

CHEMICALS.

Nitrate of Silver.—This salt, which is prepared by dissolving pure silver in nitric acid, and evaporating the solution till crystals are obtained—should only be purchased in the form of crystals;—not in the form of sticks, which are the common fused *lunar caustic* of the shops, and which generally contains impurities detrimental to its employment as a photographic agent. The crystals should be of a white colour, and perfectly free from any smell of nitric acid; should this, however, be present, the crystals must be dissolved in some distilled water, evaporated and crystallized.

Iodine.—This substance is obtained from the ashes of seaweed, called kelp, which being lixiviated with water, and all the crystallizable salts being thus separated, the mother liquid which remains is mixed with oxide of manganese and sulphuric acid, in a glass retort or other convenient vessel, and exposed to heat, when iodine rises as a fine violet-coloured vapour, which condenses in the form of steel grey opaque crystals. When pure, and fit for photographic purposes, the crystals should be well formed, and perfectly free from moisture.

Bromine.—This is extracted by a similar process to that just described for iodine, from the mother liquor of sea water (bittern). It condenses in the form of a dark red-looking liquid, very volatile, giving off a dark red vapour of a powerful and suffocating odour. It is best preserved in a well-stopped glass phial containing a small quantity of water, which, from its less specific gravity, floats on its surface, and, in a measure, prevents its evaporation.

Iodide of Potassium.—This salt is commonly prepared by saturating a solution of pure potass with iodine, evaporating to dryness, and fusing the product, which is afterwards dissolved in water and crystallized, when it forms cubical crystals of a white colour. When pure, it should not be very deliquescent; its solution in water should not effervesce on the addition of a few drops of a dilute acid, and should be perfectly soluble in alcohol.

Bromide of Potassium is prepared by mixing bromine and solution of pure potass together, and evaporating to dryness. It dissolves readily in water, and crystallizes in small cubes.

Acetic Acid.—This is manufactured on the large scale by saturating the acid liquor obtained by the distillation of wood in iron cylinders, with lime or chalk. The solution of acetate of lime formed is decomposed by sulphate of soda, with the formation of insoluble sulphate of lime and soluble acetate of soda, which latter is separated by filtration, evaporated to dryness, and distilled with sulphuric acid in earthen or glass retorts, when acetic acid passes off, and is subsequently purified by re-distillation. When required for photographic purposes it should be very carefully distilled, to prevent the formation of sulphurous acid—a substance very detrimental to its proper action; and it should also be of sufficient strength to become quite solid or crystallized when the vessel containing it is placed in ice, from which circumstance it is commonly called glacial or crystallizable acetic acid.

Gallic Acid.—This acid is obtained from the nutgall, and may be prepared by allowing a mixture of powdered galls and water, of the consistency of thin paste, to be exposed to the action of the atmosphere, at a temperature between 60° and 70°, for about four or five weeks; making up from time to time what may be lost by evaporation, by the addition of small quantities of water; at the end of this period the whole mass, which will have become mouldy, is to be dried by pressing out the liquid; the residue is now boiled in water, and the whole filtered while hot; the clear filtrate as it cools will deposit crystals of gallic acid, which may be further purified and improved in colour by boiling it with about eight parts of water and a fifth of its weight of animal charcoal, and again filtering, when pure crystallized acid will be deposited as the solution cools. One ounce of water, at the ordinary temperature, will dissolve about four grains of gallic acid.

Pyro-gallic Acid.—A quantity of gallic acid placed in a glass retort is heated to a temperature between 410° and 420°, by means of an oil bath;—the pure pyro-gallic acid sublimes in the upper part of the retort in the form of brilliant white lamellar crystals, and a blackish deposit of metagallic acid remains in the body of the retort.

Hyposulphite of Soda.—This salt can be made by decomposing hyposulphite of lime by carbonate of soda; carbonate of lime precipitates, and hyposulphite of soda remains in solution. The hyposulphite of lime is prepared by boiling for two or three hours a mixture of two parts of sublimed sulphur, three parts of fresh-slacked lime, and 200 parts of water; then filtering the clear liquid, which will be of a deep yellow colour, from its containing persulphuret of calcium, into a large, open, and shallow vessel, freely exposed to the air;—the yellow colour of the liquid will gradually disappear from the absorption of oxygen, and when colourless will have become a solution of hyposulphite of lime. Hyposulphite of soda may also be prepared according to the following process given in No. 4 of the CHEMICAL RECORD:—Mix one pound of finely-pulverized calcined carbonate of soda with ten ounces of flowers of sulphur. Heat the mixture slowly, till the sulphur melts. Stir the fused mass, so as to expose all its parts freely to the atmosphere, then dissolve in water, filter the solution, and boil it immediately with flowers of sulphur. On cooling, after being filtered, it will deposit beautiful crystals of the hyposulphite.

PHOTOGENIC DRAWING.

Although as far back as the year 1556 the blackening effect of light upon chloride of silver, or horn silver as it was then called, appears to have been well known, it was not till upwards of two centuries had elapsed that we find any recorded attempts to apply this property to the production of photogenic impressions. In the Journal of the Royal Institution for June, 1802, we find a notice of some experiments of the celebrated porcelain manufacturer, Joseph Wedgwood, and also of Sir Humphry Davy, from which it appears that both these philosophers succeeded in obtaining photographic pictures. Wedgwood, by washing over the surface of leather or paper with a solution of nitrate of silver, and placing over the prepared surface the object he wished to copy, found, on exposure to the sun's rays, that the light passed through the object in various degrees of intensity, according to the degree of transparency of its various parts, producing a corresponding blackening effect on the paper or leather beneath. Sir H. Davy also obtained impressions on paper prepared with nitrate of silver, by refracted light, by exposing it so as to receive the picture formed at the focus of a solar microscope; but, in consequence of no means being then known or discovered to prevent the further action of light after the impressions had been obtained, these important experiments, at that time, led to no conclusive result, and the subject was apparently abandoned. It was not till January, 1839, that we find a process published by which photogenic impressions could be obtained and afterwards rendered permanent. This process appeared in a paper sent to the Royal Society by Mr. Fox Talbot. The method he employed for obtaining impressions from leaves, flowers, feathers, &c., was by employing the ordinary chloride of silver paper, and fixing them by the use of common salt.

Since the discoveries of Mr. Fox Talbot, we find this interesting subject taken up by many lovers of science, who have not only discovered new processes, but also investigated the chemical changes and principles in their production. Amongst the foremost of these may be named Sir John

Herschel and Mr. Robert Hunt, to the latter of whom we are indebted for many very interesting photographic processes, termed by the inventor Ferrotype, Energiatype, Chromotype, &c., and a valuable series of experiments on the chemical action of light, which may be found in his valuable "Researches on Light;" but, as it is my intention in these papers only to give such processes and manipulation whereby photographic pictures can be obtained in the greatest perfection and certainty, I must of necessity omit others which are not practically useful, although extremely interesting in connection with the science of photography.

To Sir John Herschel we owe the *Chrysotype*, in which iron and gold are employed; *Cyanotype*, in which impressions are produced by the salts of iron in combination with those of cyanogen; *Anthotype*, where the expressed juice, watery or alcoholic infusions of the petals of the wild poppy, stock, rose, &c., are demonstrated to be effaced by the action of light, showing that the vital principle of plants prevents those changes of colour and properties which immediately take place when that influence is destroyed; and many other most interesting experiments which would tend to prove that, although the compounds of silver are those which are generally used for photogenic or photographic purposes, and they appear, as far as our present knowledge extends, to be the most influenced by the action of light, it is extremely probable that there is not a compound, of whatever nature it may be, but is affected more or less by light; and although that effect may not, in many instances, be visible, still it may exist, and only requires the substance which has been exposed to its action to be placed under different circumstances to make the effect apparent to our senses.

To render paper sensitive to light, it appears essential to have in the texture, or on the surface of the paper, a fixed salt or compound of silver moistened with a soluble salt, easily decomposed when in contact with organic matter, as the nitrate of silver, for example, which is very sensitive to light when in contact with the chloride, iodide, bromide, fluoride, &c., of silver; many of these compounds and their mixtures have from time to time been recommended for photographic purposes, and produce varied results, both as regards the colour of the picture and the time of its production. By reference to the following diagram the chemical changes that take place when a chloride is mixed with excess of nitrate of silver may, perhaps, be better understood.

Chloride of Silver.

Muriate of Barytes,	Chlorine.	Silver.	
or			Nitrate of Silver.
Chloride of Barium.		Oxygen.	
	Barium.	Nitric Acid.	

Nitrate of Barytes.

The paper being first moistened with solution of chloride of barium, and then placed in an excess of solution of nitrate of silver, the following changes of elements take place:—The chlorine of the chloride of barium combines with the silver of the nitrate, forming an insoluble chloride of silver in the paper, at the same time nitrate of barytes is formed by the union of the oxygen with the barium, producing barytes, which, combining with the nitric acid, forms a soluble nitrate of barytes, which is for the most part dissolved out in a subsequent process, leaving the chloride of silver moistened with the excess of nitrate of silver, which, as before mentioned, is the most favourable condition to receive photogenic impressions.

I shall now describe the best and simplest process for preparing photogenic paper with which I am acquainted; and first with respect to the

SELECTION OF THE PAPER.

There are various kinds of paper I have found well suited for the purpose, but that manufactured expressly by Turner, the blue wove post of Whatman, and the positive paper of "Carson Freres," of Paris, appear to produce the best results. The paper should be cut into sheets of a convenient size for manipulating, about nine inches by eight, and those sheets only are to be employed which are of an even texture and free from specks and water-marks; these specks should be carefully avoided, as they are generally small particles of iron left in the substance of the paper during the process of manufacture, and which, brought in contact with any salt of silver, speedily produces a brown stain on the paper of considerable size. The suitableness and quality of the paper is best ascertained by holding each sheet opposite a strong light, either of a window or lamp, and when approved a pencil mark should be made on one side of each sheet for the purpose of distinguishing it when required.

PREPARATION OF THE PAPER.

The chemical solutions required for this purpose are two, viz. :—

1. Ten grains of muriate of baryta dissolved in one ounce of distilled water.

2. Solution of ammoniacal nitrate of silver, containing about 50 grains of nitrate of silver in the ounce.

The ammoniacal nitrate of silver, the employment of which was first suggested by Mr. Alfred Smee, is most conveniently prepared in the following manner:—In a two-ounced stopped phial, place 50 grs. of crystallized nitrate of silver, and pour over it one ounce of distilled water. When the crystals are dissolved, some strong solution of ammonia is added, a few drops at a time, and the phial well shaken after each addition. The whole first becomes of a dark brown colour from the formation of a precipitate of oxide of silver, but, immediately the proper quantity of ammonia is added, the oxide of silver is dissolved, and the solution becomes perfectly clear; a few crystals of nitrate of silver are now added, so as to produce a slight turbidity, and it is now ready for use.

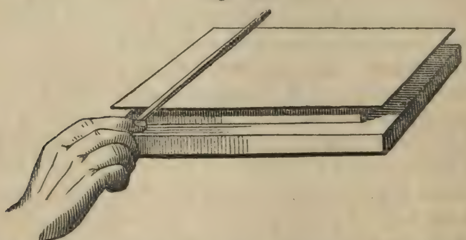
There are three equally effective methods of applying these solutions to the surface of the paper, and, as they are applicable to other processes about to be described, I shall therefore give the manipulation of each, pointing out any particular circumstance that may indicate the one to be preferred.

1. A small quantity of the solution to be applied is poured on to the surface of a horizontal glass plate, or else over the bottom of a flat earthen dish, somewhat larger than the sheets of paper to be prepared. A sheet of the selected paper is then carefully laid on to the solution, the marked side downwards, taking care that no air bubbles remain between the paper and the solution, and also that the back is not wetted; the paper will be observed to curl upwards from the solution, but this must be prevented by slight pres-

sure over the back of the paper by means of a glass rod or small stick. When the sheet of paper lies perfectly flat and loses its rigidity, at the same time becoming slightly less opaque, it is an indication that the fluid has been sufficiently absorbed. The sheet of paper may then be raised from the solution, allowed to drain for a second or two, and hung up to a cross rail of wood by two pins passed through its upper corners and into the wood. After a minute or so the superfluous fluid accumulates at the bottom edge of the sheet, and is best removed by the application of a piece of thick filtering or plate paper. Any number of sheets of paper may thus be prepared, renewing the solution as required from time to time on the glass plate or dish.

2. The sheet of paper is pinned, marked side upwards, upon a wooden board, which ought to be about a quarter of an inch smaller all round than the paper, and a smooth glass rod placed across the left end of the sheet a short distance from its edge, as shown in the following cut:—

Fig. 38.



A measured quantity of the solution to be applied is poured in front of the rod, which is then moved to and fro till the solution is equally spread, and the whole surface wetted; after allowing a few seconds for absorption of the liquid the sheet may be hung up, as before described, to dry.

3. The sheet of paper to be prepared is laid on a sheet of bibulous paper, placed on a smooth board, and secured in its position by four pins at the corners. The board is then held in the left hand in a slightly-inclined position, and the solution applied by means of a soft brush, using it in one uniform direction over the sheet, and removing it as seldom as possible; the extreme edge of the paper must be avoided; but should any of the solution accidentally flow over the

edge, it will be immediately absorbed by the bibulous paper, and the back of the sheet prevented from being stained. The paper thus wetted is allowed to remain for a few seconds, and then hung up to dry, as before explained. As solutions of silver very rapidly act on ordinary brushes, rendering them unfit for a second application, it will always be found best to employ a kind of extemporaneous brush, made with a piece of glass tube about half inch diameter, and six inches long, and a silver wire; it is thus described by the inventor, Mr. Buckle :—

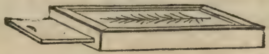
"Take a tuft of finest cotton wool about the size of a hen's egg, draw it out thin in the middle (to a form resembling an hour-glass), place the thin part in the hook of silver wire (supplied with the glass tube for the purpose), and with it draw the cotton tightly into the bell-mouthed tube. Then pull out all loose and superfluous fibres of cotton wool which readily yield, and revolve the remainder in the palm of the hand a few times for the purpose of condensing the mass into a ball. The cotton should be renewed as soon as it becomes dirty, and the mouth of the tube must be kept clean."

If the surface of the paper to be prepared be at all greasy, it will be necessary to use a slight amount of friction to cause the solution to wet the surface, in which case the glass rod, or brush, has an advantage over the other method of prepa-ation.

The first operation for preparing the photogenic paper consists in applying to each sheet, on the marked side, the solution of muriate of baryta, by either of the methods detailed, and when dry they will not deteriorate by keeping any length of time. This part of the process may be performed at any time, in the daylight if required, as light has no action on muriate of baryta. When required for use, a sheet of this prepared paper is washed over again on the marked side with the solution of ammoniacal nitrate of silver, and hung up in a dark room or cupboard to dry; when dry it should be smoothed with a glass rod, and is ready for use, and may be preserved from the light, in a portfolio, or between the leaves of a book, till required to be employed. The time between the final preparation and employment of the paper should not exceed twenty-four hours, as the prepared surface soon begins to darken and spoil.

We have now a surface so prepared that it will very quickly blacken all over if exposed to light; but it will be obvious that if one part be shaded, and the other exposed, the part covered will remain white, and the whiteness would correspond in outline to that of the body shading it. If a leaf, for example, be placed on a prepared surface of paper, and exposed to the sunlight, the paper will become black all round the leaf, but underneath the blackening effect will be according to the amount of opacity of its various parts, and an impression will be produced corresponding to the various markings of the leaf. It is necessary, however, to obtain a correct copy of the leaf, that it should be in close contact with the prepared surface, so as to prevent any light affecting the paper under the edges of the leaf, and for this purpose is employed a contrivance called a reversing or pressure frame, the simplest form of which is represented in the following cut:—

Fig 39.



Many forms of this instrument have been devised, but, being all of one principle, they may be described as consisting of one or two pieces of thick plate glass, placed in a wooden frame, with a contrivance at the back, either by a wedge or screws, to press together the two plates, or else a flat board covered with two or three folds of flannel, which can also be pressed against the front glass.

To copy objects that are flat, such as prints, drawings, &c., proceed as follows:—Place a sheet of the photogenic paper on one of the pieces of plate glass, taking care that the prepared side, which is easily distinguished by the mark made for that purpose, is upwards. The print or drawing should then be placed on the paper, printed side downwards, and a small particle of wafer or gum applied at one of the corners, so as to attach it to the prepared paper; the other piece of plate glass is now to be placed so as to press them into close contact. The whole may then be exposed to the light, the drawing to be copied being upwards.

The time required to produce an impression depends, in a great measure, upon the thickness of the paper upon which the print or drawing is made; about ten minutes in a bright sunshine, or half an hour clear daylight, is generally sufficient; but the best method is gently to slide the upper glass partially off, without disturbing the position of the print or drawing, and, by carefully lifting that part which is uncovered by the glass, see whether the impression is complete; if not sufficiently dark, return the glass to its place, and expose it some time longer to the action of the light, till the copy be sufficiently distinct.

To copy objects that are not flat, such as plants, leaves, butterflies, &c. &c., proceed as follows:—Lay the objects out as desired on one of the plates of glass, and lay carefully over them a sheet of the prepared paper, *very slightly* damped, with the prepared side next to the objects; then substitute for the lower plate of glass the board covered with flannel, and apply a moderate pressure, by which means the objects will be slightly embedded in the sensitive paper, and, after exposure to sunlight, the objects, of course, being towards the light, very beautiful and correct impressions will be obtained.

If the object be very unequal in its thickness at certain points, those parts may, in most cases, be reduced by means of a penknife, without impairing, in the slightest degree, the accuracy or effect of the copy.

There are many ways of modifying the process for obtaining photogenic drawings, from various substances and articles, which cannot fail to occur to the experimenter, and, therefore, need not be particularly described; but although the process may be used for obtaining correct copies of all small objects, either of nature or art, provided they are, or can be, made sufficiently flat, without injury, the objects that will be found best adapted for this purpose are plants, leaves, flowers, ferns, mosses, feathers, wings of insects, prints, drawings, lace, and other similar articles.

FIXING THE PHOTOGENIC DRAWING.

When an impression has been obtained by any of the means just described, it is necessary, for its preservation, that the undecomposed salt of silver remaining in the paper be removed.

The best article for this purpose is the salt called hyposulphite of soda, one ounce of which is to be dissolved in one pint of water. This solution, when about to be used, should be poured into a flat dish of sufficient size to contain the photogenic drawing to be fixed.

After a drawing has been obtained it should be washed in cold plain water for a few minutes, slightly agitating the water while the picture is immersed, to prevent any deposit taking place on its surface. It should then be laid face upward on a flat dish or glass plate, and some hot water poured gently over it, till the whole of the size of the paper appears to be removed; this is known to be the case when the water is quickly absorbed, and the surface becomes free from running liquid on inclining the dish or glass: a fold or two of white blotting paper, which should be free from lines, is then gently pressed on the surface of the drawing. The drawing is now to be laid on the solution of hyposulphite, face upwards, till the whole of its surface appears wetted by the upward absorption of the hyposulphite; it is then to be well washed in separate portions of water till the water comes off tasteless; the picture is now perfectly fixed, and may be dried and exposed to the light without any risk of injury.

The *rationale* of the fixing process is this:—The chloride of silver, which is the result of the preparation of the paper, is very soluble in hyposulphite of soda, whereas the sub-chloride of silver reduced by the light is not; the consequence is, that, when the photogenic impression is placed in the hyposulphite, all the undecomposed chloride of silver is converted into hyposulphite of silver, which, being very soluble in water, is removed by the subsequent washing.

The hyposulphite of silver having a very sweet taste, which it communicates to a large quantity of water, affords the best criterion for judging when the paper has been sufficiently washed in the fixing process just described.

NEGATIVE AND POSITIVE PHOTOGRAPHS.

A photographic impression obtained by the ordinary photogenic paper will, of course, have the light and shades reversed in regard to the original, *i.e.*, the light parts of the original will allow the light to pass through, and produce shades on the paper, whereas those parts which are thick or opaque, by obstructing the light, will remain white, or nearly so. These kinds of impressions are called *negative* ones, in distinction to those pictures where the lights and shades are as in Nature, when they are called *positive* photographs.

A photogenic copy of a print, for example, will, in the first instance, be a negative one; and in order to obtain a positive picture, or correct copy of the original, it must be reversed. This can be done by exactly the same means as were used for obtaining it in the first instance, only substituting the negative drawing for the print. In this way any number of positive copies may be obtained from one negative picture.

THE CALOTYPE OR TALBOTYPE.

The word *Calotype* is derived from two Greek words signifying "beautiful picture or image." The Calotype, or as it is sometimes called Talbotype, process, for taking pictures on paper, has been patented in this country by Mr. Fox Talbot, in whose specification it was first described; it differs in one respect from the former photogenic process, inasmuch as the image formed on the calotype paper is quite invisible when taken from the camera until washed over with a liquid containing gallic acid, when the picture gradually appears in all its details. In which particular this beautiful process bears a remarkable analogy to the daguerreotype.

To produce a calotype picture there are five distinct processes, all of which, with the exception of the third, viz., exposure in the camera, must be performed by the light of a lamp or candle, surrounded by a yellow glass, or else in a chamber where the whole of the daylight that illuminates it, first passes through a yellow glass, or several thicknessess of yellow calico; they are all very simple, but at the same time all of them require care and attention. The first, and not the least important, is—

IODIZING THE PAPER.

Much depends upon the paper selected for the purpose; it must be of a compact and uniform texture, smooth and transparent, and of not less than medium thickness. The best I have met with is a fine post paper, manufactured expressly for this process, by "R. Turner, Chafford Mill." Having selected a sheet without flaw or water-mark, and free from even the minutest black specks, the object is to spread over its surface a perfectly uniform coating of the iodide of silver.

This is accomplished either by the mutual decomposition of two salts, nitrate of silver and iodide of potassium, in the substance of the paper, or else by the employment of the double iodide of silver. In the former method the paper is first prepared on one side with a solution of nitrate of silver, made by dissolving 20 grains in an ounce of distilled water, and then allowed to dry in the dark. This application of the nitrate may be made by either of the methods detailed at page 34.

The nitrate of silver spread upon the paper is now to be saturated with iodine, by bringing it in contact with a solution of the iodide of potassium; the iodine goes to the silver and the nitric acid to the potash.

The solution of iodide of potassium is to be of the strength of one ounce to the pint of water, and is to be poured into a flat-bottomed dish in such quantity that its bottom is covered to the depth of an eighth of an inch.

The prepared side of the paper, having been previously marked, is to be brought in contact with the surface of the solution. Holding by an upturned margin, the paper is to be gently drawn along the surface of the liquid until its lower face be thoroughly wetted on every part; it will become plastic, and in that state may be suffered to repose for a few moments in contact with the liquid; it ought not, however, to be exposed in the iodine dish for more than a minute altogether, as the new compound just formed upon the paper upon further exposure would gradually be re-dissolved.

The paper is therefore to be removed, and, after dripping, it may be placed upon any clean surface, with the wet side uppermost, until about half dry, by which time the iodide solution will have thoroughly penetrated the paper, and have found out and saturated every particle of the silver, which it is quite indispensable it should do, as the smallest portion of undecomposed nitrate of silver would become a black stain in a subsequent part of the process.

The paper is now covered with a coating of the iodide of silver; but it is also covered, and indeed saturated, with saltpetre and with the excess of iodide of potassium, both of which it is indispensable should be completely removed. To effect the removal of these salts, it is by no means sufficient to dip the paper in water; neither is it a good plan to wash the paper with any considerable motion, as the iodide of silver, having but little adhesion to it, is apt to be washed off. But the margin of the paper being still upturned, and the unprepared side of it kept dry, it will be found that by setting it afloat on a dish of clean water, and allowing it to remain for five or ten minutes, drawing it gently now and then along the surface, to assist in removing the soluble salts, these will separate by their own gravity, and, the iodide of silver being insoluble in water, nothing will remain upon the paper but a beautifully perfect coating of the kind required.

It is also a good plan, to ascertain if all the superfluous iodide has been removed, to let a drop of the liquid from the surface of the paper fall into some solution of nitrate of silver; if it produce a precipitate the paper must be washed for some time longer; if no precipitate is produced, it may now be dried; but, while wet, do not on any account touch or disturb the prepared surface with blotting paper, or with anything else. Let it merely be suspended in the air, and, in the absence of a better expedient, it may be pinned across a string by one of its corners. When dry it may be smoothed by pressure. It is now "iodized" and ready for use, and in this state it will keep for any length of time.

To iodize paper by means of the double iodide of silver, which process I always follow, being the most simple, proceed as follows:—Dissolve in an ounce or so of distilled water about 20 grains of nitrate of silver, add to this 20 grains iodide of potassium dissolved in an ounce of water. A precipitate of yellow iodide of silver is formed, and is to be allowed to settle to the bottom of the vessel; then drain off the clear supernatant liquid, and wash the precipitate two or three times with warm distilled water, allowing the precipitate to settle each time, before pouring off the liquid. The iodide of silver, being now freed from any soluble nitrate of potass or other impurity, is to have sufficient distilled water poured over it to make up one fluid ounce, and the whole well stirred with a glass rod. Crystals of iodide of potassium are now added by small quantities, or even single crystals at a time, ascertaining that each crystal is dissolved before the addition of another. The solution will gradually become clearer, and at last perfectly bright, forming the double iodide of silver. The application of the double iodide to the paper is best performed by means of the glass rod, as described at page 34; and when the surface of the paper has become nearly dry it is placed in a vessel of plain water, which must be changed five or six times during a period of nearly half an hour, or till the surface of the paper becomes of a lemon-yellow colour, and a drop of the liquid from its surface fails to produce a precipitate in solution of nitrate of silver. It may then be hung up, and when dry may be smoothed by pressure. When preparing a number of sheets, it is best to employ two or more vessels of water, which may be alternately changed, the whole of the sheets being first placed in one of the vessels, and then removed, one by one as required, to the other.

The action of this process is due to the fact, that iodide of silver is soluble in a strong solution of iodide of potassium, forming the double iodide, as it is termed, which, being decomposed on the addition of water, forms a precipitate of iodide of silver in the substance of the paper, at the same time the iodide of potassium is dissolved out by the water.

The iodized paper, prepared by either of the foregoing processes, will keep any length of time; it is not in the least sensitive to light, and should bear exposure to the direct rays of the sun without its colour being affected, otherwise the process has not been properly conducted, and the exposure, far from being injurious to it, seems, on the contrary, to increase its sensitiveness. The second process is that of exciting, or—

PREPARING THE PAPER FOR THE CAMERA.

For this purpose are required the two solutions described by Mr. Fox Talbot, namely, a saturated solution of crystallized gallic acid in cold distilled water, and a solution of the nitrate of silver, of the strength of fifty grains to the ounce of distilled water, to which is added a drachm and a half of glacial acetic acid. The solution of gallic acid is made by placing four or five grains of the crystallized acid in a phial, and pouring over it about an ounce of distilled water: the phial and contents are then well shaken for a few seconds, and the solution poured upon a filter (see page 25); the clear liquid that comes through will be a saturated solution of the acid, and if slightly heated, by placing the bottle containing it for a few minutes in some boiling water, it will keep good for a considerable time. When these solutions are about to be applied to the iodized paper, three drops of each should be added to one drachm of distilled water, and the mixture, which is now termed gallo-nitrate of silver, is to be poured upon a clean and level slab of plate glass, diffusing it over the surface to a size corresponding to that of the paper. The prepared side of the sheet of iodized paper is to be applied to the liquid upon the slab, and brought in contact with it, by passing the fingers gently over the back of the paper, so as to exclude any air bubbles, taking care that it is not soiled by the solution. As soon as the iodized paper is wetted with the gallo-nitrate, which is known by its ceasing to curl up, it must be removed and laid face upwards in a dark box or drawer until the excess of the gallo-nitrate is absorbed from its surface; it may now be placed, while still damp, in the camera frame between the plate glasses ready for use, by which it is protected as much as possible from the action of the atmosphere. If properly prepared it will keep perfectly well for four and twenty hours at least, preserving all its whiteness and sensibility.

If the paper is required of its utmost degree of sensitiveness, as for portraits, the quantity of water employed to dilute the gallo-nitrate may be greatly reduced, even to a few drops, in which case the whole of the process must be quickly and skilfully performed, as it rapidly decomposes, and will not keep longer than two or three minutes. The degree of dilution must in a great measure depend upon the judgment of the operator, and should be proportioned to the brightness of the day, or brilliancy of the object, the foregoing proportions being the best average strength that can be given. The third process is that of—

THE EXPOSURE IN THE CAMERA,

for which, as the operator must be guided by his own judgment, few directions can be given, and few are required, as the peculiar manipulation for each form of camera has been before described. He must choose or design his own subject; he must determine upon the aperture to be used, and judge of the time required, which will vary from a few seconds to eight or ten minutes. The subject ought, if possible, to have a strong and decided effect; but extreme lights, or light-coloured bodies in masses, are by all means to be avoided. When the paper is taken from the camera slide, very little, or more commonly no trace whatever, of a picture is visible until it has been subjected to the fourth process, which is—

BRINGING OUT THE PICTURE.

This operation should be performed with the like amount of care that was required to prepare it for the camera, both as respects the perfect cleanness of all the vessels employed, either for mixing or applying the chemical solutions, and the avoiding all excess of light, beyond what is required for convenient manipulation.

The solutions required for bringing out the latent picture, are the same as those employed for preparing the paper, viz., solution of gallic acid, and aceto-nitrate of silver. These solutions should be mixed in equal proportions, say half a drachm of each, to which add half a drachm of distilled water. This mixture is to be applied to that surface of the paper on which the latent image is formed by either of the methods before described, taking care that the whole of the surface be thoroughly wetted; it is then laid, face upwards, on a plate of glass or other clean substance, and the picture will be observed to gradually appear in all its details.

During the development of the picture, it is necessary to keep the surface wet, otherwise the light parts of the picture sink, and become opaque; this is done by applying, when necessary, a fresh quantity of the mixture of gallic acid and aceto-nitrate of silver. If the picture is very tardy in making its appearance, which will generally be the case in cold weather, it can be much accelerated by the cautious application of heat, and a better result by this means obtained than would otherwise be produced. The best method of applying heat is by holding the picture over the steam from some hot water, placed at the bottom of rather a deep dish.

If any part of the picture, although wet with the "gallo-nitrate," should begin to stain, and give indications of the appearance of dark waves, before the whole is sufficiently developed, it will be found the best plan instantly to remove the whole of the excess of the "gallo-nitrate" from its surface; this is done by placing the picture, face upwards, upon a piece of clean blotting paper placed on a smooth board or glass plate, and then by a smooth glass rod lightly pressed on one end of the picture, and moved briskly to the other, the whole or greater portion of the decomposing gallo-nitrate will be removed. A quantity of the solution of gallic acid alone is now to be poured over the surface of the picture, which will enable it to become sufficiently developed without the formation of any stains.

When the picture is sufficiently clear and defined, it will require to be immediately subjected to the next operation, which is—

FIXING THE PICTURE.

The object in this process being to remove the excess of nitrate of silver, and also of the yellow iodide of silver, it will be found advisable in the first instance to place the picture, or photograph, as it may now be termed, face downwards, in a vessel of clean water, which must be changed three or four times during a period of eight or ten minutes, the photograph during that time being kept in slight motion and prevented from settling at the bottom of the vessel; it may now be removed and pressed between some folds of clean white blotting paper, which, as before mentioned, for all photographic purposes, must be free from lines and water marks.

The greater portion of nitrate of silver being removed by the washing, the remainder, together with the iodide of silver, is to be dissolved out by placing the photograph in a warm and strong solution of hyposulphite of soda, containing about four ounces to the pint of water; it may remain in this solution for a few minutes, or till the yellow colour of the iodide disappears, after which it must be washed in a considerable quantity of common water, and finally, to ensure the whole of the hyposulphite of silver being removed from the paper, may be suffered to remain for a few hours in a fresh quantity of water; on removal from which, and drying between folds of blotting paper, it will be found perfectly fixed, and will undergo no further change when exposed to the light.

The photograph thus obtained is a *negative* picture, *i.e.*, the positions of the objects, together with all the lights and shades, are reversed in respect to their natural appearance, and, although its production may appear somewhat tedious, it well be found by no means difficult. If the chemical agents be perfectly pure, the apparatus properly constructed, the *intention* of each separate process kept in view, and the manipulation recommended correctly followed, the operator may rely with confidence on a satisfactory result.

THE PRINTING PROCESS.

The negative photograph obtained by the process described in the preceding pages is capable of yielding a vast number of beautiful impressions, in which the relative positions and perspective of the various objects, and their lights and shades, will be correct as in nature. There are many methods of obtaining these impressions as regards the prepared paper employed; the best process with which I am acquainted is precisely that described at page 35 for photogenic drawing. The best method of preparing the negative photograph is to lightly burnish the surface on which the picture is impressed by means of a steel or agate burnisher; the photograph is laid on a smooth glass plate, and the burnisher applied to various parts of its surface, till the whole assumes an equally polished and smooth appearance. By this operation the parts of the paper rendered woolly by the various washings, &c., are pressed together and made more pervious to the rays of light, and some fine portions of detail are brought out and rendered capable of being produced in the printing, in consequence of the surfaces being brought into close contact.

It sometimes happens that the light parts of the negative are not sufficient to yield good impressions, in which case they can be improved by scraping a small quantity of white wax over the surface of the picture; a sheet or two of blotting paper being then laid over the wax, and a hot flat iron passed a few times over the blotting paper, the wax becomes absorbed and the picture rendered more permeable to light.

The sheet of paper prepared with the muriate of baryta and nitrate of silver, and upon which the positive impression is to be made, should be perfectly flat and smooth; upon this is laid, face downwards, the negative photograph, placing a particle of wafer at one or more of the corners, and, the whole being placed in the reversing frame, is exposed to the light. The printing process should be allowed to proceed some time longer than the shade of tint would lead the operator to suppose, as the tint of colour is slightly lightened by the subsequent fixing process; at the same time it should not be carried so far as to injure the lights of the picture. The details of the printing process, and also of the method of fixing the photographs, having been fully described before at page 35, need not be repeated here.

When the photograph is finished it should be preserved from all damp and dust, and kept in the light, otherwise it is apt to slightly fade. This can conveniently be done by giving it a coating of gelatine over its surface, or mounted in the usual way with a glass in front.

DAGUERREOTYPE.

The daguerreotype is a process by which correct copies of objects can be made from nature on polished surfaces of silver. It derives it appellation from its inventor, M. Daguerre, an ingenious French artist, who published the process in August, 1839, for which he, together with M. Niepce, who assisted him in his investigations, received the grant of an annuity from the French Government.

The process was patented in England by Mr. Berry, in 1839, and in his specification is called "A new and improved method of obtaining the spontaneous reproductions of all the images received in the focus of the Camera Obscura;" since which time it has been greatly improved, and still is improving in many particulars, especially as regards its simplicity and quickness of action.

DESCRIPTION OF THE PROCESS.

Daguerreotype pictures, as they are called, are taken on copper plates, covered with a coating of silver, which should be as pure as possible, and of sufficient thickness to allow of its being very finely polished. A superior description of Sheffield plate is the kind generally used, which, after being cut to the sizes required, is flattened or planished by the hammer, and afterwards polished on a lathe to the required surface. These plates, properly prepared and cut to any size, can be obtained ready for use.

There are several varieties of these plates under the names of English and French plates, manufactured, as the names import, in those countries. The plates manufactured in England are generally thicker and have more silver on them than the foreign, from which circumstance they can receive a finer surface, and are more applicable for beginners, as they will bear being cleaned for a great number of times. The French plates being cheaper than the English can be employed when practice has enabled the operator to be nearly certain of his results; they are usually marked 1·40 and 1·30, indicating the quantity of silver on them. and consequently their quality: those marked 1·40 will scarcely admit of being used a second time, but the other may, perhaps, with care, be polished three or four times without removing the silver.

The method of proceeding consists of six distinct operations, viz.:—

1. Cleaning the silvered plate.

2. Rendering its surface sensitive to light, by exposing it to the vapour of iodine, bromine, or their combinations with chlorine, &c.

3. Exposing the prepared sensitive plate to the focus of either a refracting or reflecting camera.

4. Bringing out the picture by exposing it to the vapour of mercury.

5. Removing the sensitive surface of the plate which has not been acted upon by the light.

6. Fixing the picture by giving it a coating of gold, and drying.

CLEANING THE SILVERED PLATE.

The object in this operation is to obtain a perfectly pure and polished surface of silver; it is therefore of the greatest importance that the articles used in the latter part of the process should be perfectly free from grease or any other article of a fixed oily nature. Many ways and substances have been proposed for these purposes; but the following methods I have generally found produce the best results, and are most simple in their details. The materials required are calcined tripoli, prepared lampblack, rouge, and olive oil.

The calcined tripoli should be in a state of an impalpable powder, and perfectly free from any large particles, which would cause scratches on the plate; it is best kept for use in a metal or wooden box, contrived expressly for this purpose, the open end of which is closed by a piece of fine muslin tied over it, and the whole covered with a lid to protect it from the dust.

The lampblack should be prepared by making it red hot in a crucible till vapours cease to arise from it; the crucible may then be removed from the fire, closely covered up, and allowed to cool. The lampblack thus burnt, should be reduced to a fine powder in a glass or porcelain mortar, and the portion required for use kept in a similar box to that employed for the tripoli.

The rouge should be the finest washed that can be obtained, and may be kept in a similar box to the other materials.

The first process, which is that usually adopted at the photographic establishments where large quantities of plates are wanted for use, requires a lathe, to the head of which can be adapted, by means of the proper screws, a series of circular buffs, the usual number being three. These buffs consist of circular disks of wood, one side of which is covered with a fold or two of unbleached cotton velvet. The buff No. 1 is prepared with olive oil and tripoli; No. 2 with tripoli alone; and No. 3 with lampblack and a small quantity of rouge, or lampblack alone. The plate to be polished is placed in a shallow cavity on the surface of a flat piece of metal, having a projecting tube at its back, and into which is placed a circular iron rod, mounted with a wooden handle, for the purpose of pressing this metal holder and its contained plate against the circular buff.

The method of proceeding is as follows:—Screw on the buff No. 1, adding, if necessary, some fresh tripoli and oil, and place the lathe-rest about three inches from its surface; the plate is now pressed lightly against the buff, a short distance from its centre, supporting the iron pivot against the rest. The lathe being put in motion by the foot, causes the plate to revolve very rapidly over the buff, and very quickly removes from it any former picture, scratch, or tarnish. The plate and its holder should now be lightly wiped with a portion of cotton wool, to remove as much as possible of the superfluous oil, &c. The buff No. 2 is now to be substituted for the oil buff, and the plate again applied in the way just described, till all appearance of oil is removed, and the plate appears equally polished. The plate is now laid, silver side upwards, on a stand, similar to the one here represented, and

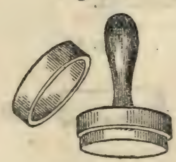
Fig. 40.

the flame of a spirit lamp applied underneath till a slight smoke appears to rise from it, and its surface assumes a slight white tint; by this process the remaining traces of oil are burnt away, and the plate is ready to receive its final polish by means of the buff No. 3.

When the plate is properly polished, its surface should look quite black and free from scratches when viewed in a particular light. If this is not the case, it must be applied some time longer to the buff No. 3 till that result is produced.

The other method of polishing where a lathe cannot be obtained, or would not be admissible on account of its cumbrous nature, consists in employing a series of cotton velvet buffs, varying in size from 3 inches by 12 inches, to 9 inches by 18, according to the size of the plates. The least number required is four; the first buff is prepared with tripoli and oil; the second and third with tripoli alone; and the fourth with prepared lampblack and a very small quantity of rouge; they must be kept separate from each other, and each carefully reserved for its own particular use. The method of proceeding is to lay the plate, face downwards, upon the oil buff No. 1, and then, by means of a similar plate-holder to that employed for the lathe, or else one made of wood of the form represented in the cut, the plane surface of which is rendered adhesive by some prepared India-rubber, the plate is briskly moved over its surface with a very slight pressure for the space of a minute or so; it is then cleared from adhering oil, &c., with some cotton wool, and rubbed lightly first on No. 2 buff, and afterwards on No. 3, adding some fresh dry tripoli as required. The plate is now heated with a spirit-lamp, and as before described, finished on the buff No 4.

Fig. 41.

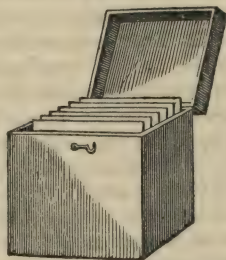


If the plate to be polished be very free from scratches, and has not been subjected to the setting process with salt of gold, the use of the oil buff may be dispensed with, and those prepared with tripoli and lampblack alone used.

The following are the most important precautions to be observed to ensure the proper result in the foregoing processes The buffs and polishing materials should be carefully preserved from dust, dirt, and damp; the former of these is easily accomplished by keeping each separate buff in its own case, which may be made either of wood or parchment, and the latter by keeping them in some dry place. If there should be any doubt relative to the buffs being perfectly dry, it will be advisable to place them, well protected from dust, before a fire, a short time previous to using.

When the plate is polished by either of the processes described, it may be protected from injury in a wooden or metal box, similar to the one represented in the cut.

Fig. 42.



When the plate is about to be used, it should receive a final polish, and have its grain laid, as it is termed, in a particular direction, by means of a buff, either covered with cotton velvet, or what is preferable, a piece of smooth, soft doe-skin, of the shape here represented.

Fig. 43.

The plate of a small one can be supported on the ends of the fingers of the left hand, using the buff with the right; if the plate be too large or thin to be supported on the fingers, any convenient form of plate-holder can be employed, taking care that it is perfectly free from dust or grease. The buff should be briskly rubbed over the plate with a slight degree of pressure for a few seconds, or till all the fine lines on the surface of the plate appear in one uniform direction, bearing in mind that for portraits the lines should not be in the direction of the face, but across it; and for views, in the direction of the view.

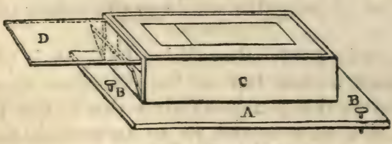
The plate is now ready, and should immediately be subjected to the next operation, which is—

APPLYING THE SENSITIVE COATING.

The simplest form of apparatus necessary for this purpose consists of two porcelain or glass pans, ground on the edges and furnished with plate-glass covers, and a series of wooden or metal frames of the size of the plate to be prepared; one of these pans is for holding the iodine, and the other the accelerating material. The plate to be prepared is placed in its proper frame, and substituted for the plate-glass cover of either pan, as may be required; the progress of the preparation being observed from time to time by the tint of colour produced on the plate when removed for an instant and viewed at such an angle that the light transmitted through a sheet of white paper held before the plate may be reflected to the eye. When the proper colour is obtained, the plate is exposed for an instant or two longer, to remove any effect of the light, and then rapidly placed in the camera frame: the glass cover is now replaced.

In consequence of being obliged to remove the cover of these pans to observe the colour of the plate, the vapour of iodine, &c., within the pan becomes disturbed, and rarely produces an even coating: this is avoided by using the glass pans of greater depth, and mounted as shown in the accompanying cut:—

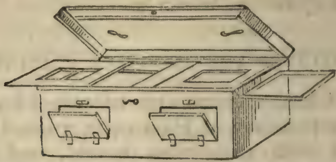
Fig. 44.



The plate to be prepared is placed in the proper opening at the top of the box, and on removing the glass sliding-cover, and replacing it again before the plate is removed, a much better result is obtained.

The only form of apparatus that can be relied upon for producing a uniform good result is that shown in the cut, or one constructed on similar principles.

Fig. 45.



It is technically termed a bromine apparatus, and consists of two deep glass pans with polished sides, and mounted in a wooden box, at the back of which are two openings, corresponding to the two pans, over which is fastened a piece of white paper. In the front of the box, and immediately opposite the back openings, are two small doors opening outwards, and each lined with a piece of looking-glass. Two glass covers, and a series of wooden frames sliding over them on the top of the box, complete the apparatus. From half to one ounce of pure crystallized iodine is placed at the bottom of one of the pans and the accelerating material in the other, and they are then closed with their respective covers, and the whole apparatus placed before a window with a moderate light.

The accelerating material which I have uniformly found produce the best and most certain results is a chloride of bromine, made by mixing one ounce of a saturated solution of bromine with one drachm of strong hydrochloric acid: this preparation must be kept in a stopped phial. Water is poured into the glass pan of the bromine apparatus to the depth of about half an inch, and sufficient of the chloride of bromine added to bring the whole to the colour of very pale sherry.

The plate to be rendered sensitive to light is placed in its required frame at the top of the bromine apparatus and immediately over the pan containing the iodine; the plate-glass cover is then removed so as to expose the plate to the vapour of the iodine below; the small mirror is now so adjusted that by looking into it the white paper at the back can be seen reflected from the surface of the silver plate, and any change of colour immediately perceived. When the plate has assumed a light straw colour, the cover is to be returned over the iodine, and the slide holding the plate shifted over the pan containing the chloride of bromine; the cover is now to be withdrawn, the mirror adjusted as for the iodine; and the glass cover being removed, the plate is exposed to the vapour till it becomes of a deep yellow colour, when it is returned over the iodine till of a rose tint, and immediately placed in the camera frame. The dilute solution of chloride of bromine will serve to prepare a considerable number of plates; and when it fails to produce its effect it will always be found the better plan to mix a fresh quantity rather than increasing its strength by the addition of more of the strong solution.

There are a great many preparations of bromine known by the names of eau bromée, bromide of iodine, Hungarian solution, Woolcott's American accelerator, bromide of lime, &c., which are employed by some operators with much success.

When the bromide of iodine, or Hungarian solution, is employed, they should be diluted with four or five times their bulk of water, and the plate, previously iodined to a deep yellow exposed to them till of a deep rose or violet colour. Woolcott's accelerator and bromide of lime both require the same tints as the chloride of bromine before described. The bromide of lime, chloro-bromide of lime, and other dry accelerators of that character, are used in the bromine apparatus, spread evenly over the bottom of one of the pans to the depth of about a quarter of an inch.

Should the plate by accident be left too long over the iodine in the first preparation, and show some indications of a rose tint, it must be brought to a full rose over the accelerator, and then to a blue over the iodine; this will often produce a good result, and save the trouble of repolishing the plate.

The plate, after being prepared by one or other of the foregoing processes, must be returned to the dark box or camera back till required for the next process, viz.:—

EXPOSURE IN THE CAMERA.

The mode in which this is effected must, of course, depend upon the construction of the camera, whether it have a lens, as originally proposed by Daguerre, or a concave mirror or speculum, which is the apparatus patented in this country by Mr. Beard. Both kinds have their advantages. The refracting camera, as recently improved, appears to possess all the capabilities without many of those inconveniences which attend on the manipulation with the reflecting camera, and, being withal less expensive, is now the form generally used.

The first thing to be attended to, before introducing the plate, is to place the camera on some firm support, and opposite to the object wished to be copied; after which the focus should be adjusted with the greatest care till a perfectly clear and distinct image of the object is seen on the piece of ground-glass, which should be placed in exactly the same position as the plate is to occupy, taking especial care that the ground side of the glass should correspond to the prepared surface of the plate. When the focus is obtained, the light should be shut off by a brass cap or other contrivance for that purpose till the plate is introduced, or the camera may be taken into a dark room, and have the plate put into its place, when it can be brought into the light, having, of course, made those obvious arrangements that the object and the camera be placed in precisely the same relative positions they occupied when the focus was adjusted.

The camera may then be opened to allow the light to fall on the plate through the lens. The time requisite for it to remain open will depend, in a great measure, upon the season of the year, time of the day, and the brightness or clearness of the atmosphere. The time usually required with a good achromatic and a well-constructed camera varies from one to sixty seconds.

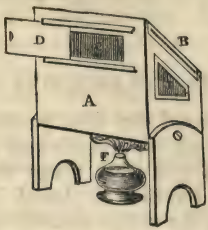
When the camera has been opened a sufficient time, which can only be determined by observation and experiment, close the front aperture, and take it into a dark room, when the picture, which is impressed on the sensitive surface of the plate, is to be made visible by being exposed to the fumes of mercury.

MERCURIALIZING THE PLATE.

The apparatus required for this operation is called a mercury-box, and is shown in the accompanying cut:—

The body, A, is made of wood, and has an iron cup, fixed in the bottom, for holding the mercury, which is heated by a spirit-lamp, F; the upper part of the box, A, is grooved, so

Fig. 46.



as to receive the same sliding frame, B, that fits the back of the camera, and holds the prepared plate, or else the prepared plate alone; at the front of the box is a small yellow glass window, C, over which slides a shutter, D. When about to be used, pour a small quantity of pure mercury (four to six ounces) into the metal cup at the bottom of the box; the mercury should then be heated by means of a spirit lamp, till the outside of the metal cup can be touched with the finger without much inconvenience. The plate may then be taken from the camera and placed in the mercury-box; and, after a short time, by cautiously applying a lighted paper to the side, and looking through the glass in front, the development of the picture can easily be perceived.

If the mercury be made very hot, the picture soon makes its appearance; but, generally speaking, when done too rapidly, the minor details are lost, and the plate is apt to become spotty; it is always advisable, where time is not a great object, to do the operation rather slowly than otherwise, as a much clearer and sharper outline of the picture will be obtained by this means than if done rapidly. The usual time required is from five to twenty minutes.

If the mercury box be furnished with a thermometer, which is sometimes the case, the temperature may be kept about 90°.

The mercury should be perfectly dry and free from any particle of oxide, and should be poured into a bottle after each series of experiments. When it loses its brilliancy, it may be purified by filtering through a paper cone, having a very fine opening at the bottom. The mercury-box ought also to be carefully dusted out before using.

When the picture has become sufficiently distinct, it should be removed from the mercury-box, and subjected to the next operation, viz.:—

REMOVING THE SENSITIVE COATING.

The solution required for this purpose is made by dissolving two ounces of hyposulphite of soda in one pint of water; this solution will serve many times if it be filtered before using. The solution is placed in some convenient shallow vessel, and the plate quickly immersed in it; the colour will be observed to gradually disappear, and when that is the case it should be placed in a vessel of filtered water, to remove the excess of hyposulphite, and subsequently a small quantity of distilled water poured over its surface.

FIXING THE PICTURE.

The solution of gold which is required for this process is prepared by dissolving 15 grs. of chloride of gold in one pint of water, and adding it, little by little, to a mixture of 60 grs. of hyposulphite of soda and eight ounces of water, the whole being well agitated between each addition. The solution, at first slightly yellow, becomes afterwards perfectly limpid; and the solution of gold being poured over its surface until it is perfectly covered, and the flame of a large spirit lamp applied to the under surface, moving it gently backwards and forwards, that every part may be equally heated, the picture will be seen to brighten, and become in a minute or two of great force. When this effect is produced, the liquid should be thrown off, and the plate instantly dipped into water, washed, and dried. If the plate be a large one, it is most conveniently dried by placing it on a smooth and clean piece of copper or tin plate, and some boiling distilled water poured over its surface, at the same time inclining the plate, so that the water may run off from one of its lower corners, and it will in a very short time become perfectly dry. Before the surface of the plate becomes dry, it is to be placed, face upwards, upon the fixing stand, which is so constructed as to preserve it in a perfectly horizontal position by means of levelling screws.

If the plate be of a small size, it can be conveniently dried over a spirit lamp. It should be held, by means of a small pair of pliars, by one of its corners, and some filtered distilled water poured over its surface; by inclining the corner held by the pliars, the greater portion of the liquid will flow to that part, and can be removed by touching it with a piece of rag or blotting paper; the spirit lamp may then be applied to the upper corner of the plate till it begins to dry, and the flame gradually brought lower down, till the whole surface is finished. Gently blowing downwards on the plate will expedite the process, as well as prevent, in a great measure, the formation of spots.

It sometimes happens that, while the plate is being heated with the solution of gold, a film of silver detaches itself and swims in the liquid, of course destroying part of the picture. This accident is probably owing to the oxidation of the silver while under the influence of too much heat.

The lamp should be removed as soon as small bubbles of air appear to form on the surface of the metal. When the picture is not perfectly fixed, it is better to make a second trial, rather than run the risk of spoiling a good picture by trying to fix it perfectly the first time.

COLOURING DAGUERREOTYPES.

As objects copied by the daguerreotype process are only represented in light and shade, not in the colours as they appear in nature, it has been suggested, after the picture has been set, to colour them by hand, similar to a painting; and certainly, when done in an artistic skilful manner, it produces a very pleasing effect. The simplest method is to use dry colours, ground extremely fine, with some dry gum or starch. The picture must be well set with gold, and the colour applied or dusted on with a fine camel's-hair pencil, taking up a very small quantity of colour at a time, removing the superfluous colour by blowing it off with a caoutchouc bottle; when the desired tint is produced, breathing on the plate will cause the colour to adhere. Mr. Claudet's method is to mix a small quantity of the colour with spirit of wine, applying it to the plate with a camel's-hair pencil, and if not sufficiently dark, some of the dry colour is applied over it, to which it will adhere. As a general rule, the colours should be applied very cautiously, as it is very difficult to remove them when once on the plate. The best colours to be used are carmine, chrome yellow, and ultra-marine, by combining which any desired tint may be obtained.

ELECTRO-SILVERING DAGUERREOTYPE PLATES.

A perfectly pure surface of silver can be precipitated by the agency of a galvanic battery on an ordinary daguerreotype plate, and by some operators is thought to add much to the brilliancy of the proofs subsequently obtained on such plates. The apparatus necessary consists of a Smee's battery and glass depositing cell; the battery is charged with a mixture of one part of sulphuric acid and seven or eight parts of water, and the depositing cell with argento-cyanide of potassium, made by dissolving two drachms of the oxide of silver in a mixture of one ounce of cyanide of potassium and eight ounces of water. A piece of silver foil, about the size of the daguerreotype plate, is to be placed in the depositing cell, and attached by means of a silver or copper wire to the silver plate of the battery; a similar wire having a small binding screw at one end, is fastened to the zinc of the battery, and the plate to be silvered is fixed on the small binding screw. The daguerreotype plate, which must be perfectly clean and free from grease, is now immersed in the depositing cell, immediately opposite to, and about half an inch from, the silver foil; in about eight or ten seconds a sufficient coating of silver will be deposited, when the plate may be removed and well washed in plain water, and after drying with a small quantity of cotton wool and tripoli, it may be polished with the lampblack buff, and is ready to be iodized, &c., as an ordinary plate.

PHOTOGRAPHY ON GLASS.

In consequence of the perfect transparency and evenness of glass plates, which render them particularly adapted for photographic purposes, many processes have from time to time been devised for rendering them available, by spreading films of various substances, such as albumem, gelatine, serum, starch, collodion, &c., which are then rendered sensitive to light by being impregnated with iodine and various salts of silver. The best processes with which I am acquainted are those in which albumem or collodion are employed to produce the necessary film.

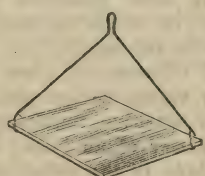
The employment of albumenized glass plates is extremely convenient for taking views, as the plate is employed dry, and although not very sensitive, requiring an exposure in the camera of about a quarter of an hour; still the results are very beautiful, the whole of the detail of the picture being well developed, and the shades marked and distinct. The most successful manipulators with albumenized glass plates with whom I am acquainted are the Messrs. Ross and Thompson of Edinburgh, to whom I am indebted for the following description of their process.

ALBUMENIZED GLASS PLATES.

"Break three or four eggs into a dish, keeping out the yokes, and also the non-transparent parts of the whites, add to the white of each egg ten drops of a saturated solution of iodide of potassium, and also one drachm of pure water, beat the whole well up into a firm froth, and allow it to stand one night, when the liquid part will be found to have fallen to the bottom. It is then ready for laying on the glass plate, which is done as follows:—

"Having cleaned the glass well, first with a weak solution of caustic potass, and finished with pure water, and dried with a silk handkerchief; the glass is fastened into a sort of brass wire forceps at the two opposite corners, represented at fig. 46; it is then held in one hand, and the egg poured on the clean side; allow it to spread over as equally as possible; it is then slanted quickly up and turned before a clean clear fire by a worsted thread which is attached to

Fig. 47.



the wire forceps, exactly on the same principle as a roast-jack, it is turned at a moderate rate—not too quick, or it throws it all off from the centre; and if too slow, does not make it equal; at a moderate fire; about four minutes is sufficient to dry it, but it must be taken away when it begins to crack at the edges; it will then crack equally over of itself. With a little practice nothing can be more simple than the above mode, or more certain;—in this state it will keep any length of time.

"Previous to taking a picture we dip it face downwards in a flat glass dish containing a solution of nitrate of silver, seventy grains to the ounce of water, as well as the usual proportion of acetic acid (one and a half drachms). It is then washed in a dish of pure water, by dipping three or four times, and keeping thewater always running off the same way to prevent streaks; it is now placed in the camera, and if it is a light coloured building or distant view, it will require from three to four minutes' exposure with an ordinary lens; but if the view be dark or green, it will take much longer.

"When taken out of the camera it is washed over with a solution of gallic acid, and allowed to develop well; when a little of the nitrate of silver is mixed with fresh gallic acid and poured on the picture (and spread with fine cotton, as the gallic acid at first should be), which will strengthen it to the proper degree. It is now fixed with hyposulphite of soda, which can be poured on a corner and spread with clean cotton; to finish it entirely it is only now to be washed in clean water, which can be done by pouring a little along the edge of it, and allowing it to run down the face in one direction; it is best to allow it to dry by itself.

"If the glass negatives are taken proper care of, the number of impressions that can be taken from them are unlimited; we have some that several hundreds of impressions have been taken from."

In obtaining portraits or views embracing objects likely to move, the glass plate prepared with collodion (a solution of gun-cotton and ether) will be found the simplest and most rapid method of obtaining photographic pictures that has yet been discovered. The only drawback to its employment for views is the necessity of fixing the plate while damp, for if allowed to dry it loses all its sensibility; it can, however, be employed by using a properly contrived tent or covering of yellow calico, where a dark room is not to be obtained close to the view required to be taken. In portraits and the like purposes, it is all that can be desired for simplicity and quickness; as the plate can be prepared, the portrait taken, and the picture set in the space of less than five minutes, and that by only a little practice.

There are several methods of preparing the collodion, but the best with which I am acquainted is a slight modification of one described by M. Levonius:—Half an ounce of dried nitrate of potass in fine powder is to be mixed with threefourths of an ounce of ordinary strong sulphuric acid of sp. gravity, about 1·850, in a porcelain capsule, with a glass rod, and half a drachm of clean dry cotton is then added as quickly as possible, and stirred about in the mixture for about five minutes; when removed, it is to be carefully and thoroughly washed with water, and dried by exposure to a warm atmosphere. Ten grains of the gun cotton thus obtained are dissolved in half an ounce of sulphuric ether, to which is added one drachm of alcohol. Five grains of iodide of potassium are now dissolved in the smallest quantity of water, and added to the collodion, together with about three ounces of sulphuric ether, so as to enable it freely to flow over a glass plate.

A few grains of iodide of silver dissolved in the iodide of potassium increase its sensibility, in which case the preparation must not be used until it has become clear, by allowing the superfluous iodide to settle, or a multitude of black specks will be formed on the plate. The prepared collodion can also be purchased ready for use of the publishers of this "Guide."

One of the most successful operators with collodion has been Mr. F. Horne, who has given me the following detail of his manipulation.

ON THE COLLODION PROCESS.

BY F. HORNE.

The practice of collodion divides itself into the following branches, viz., cleaning, coating, and exciting of plate, reception and development of image, and finally fixing and preservation of the same from injury. We will therefore first take the—

CLEANING OF PLATE.

Much has been written upon this subject, and a variety of substances, such as tripoli, nitric acid, spirits of wine, &c., recommended, but all these are quite superfluous, and the only articles actually necessary are a clean cloth or two, and a wash leather that has been well and thoroughly rinsed through several changes of clean water, to deprive it as much as possible of the dressing which a new one contains, and a little liquid ammonia, not strong but the ordinary *liquor ammoniæ* of the shops. If this is not at hand, a little caustic potash or soda will answer as well, the purport of it being to remove any greasy matter attached to the surface, as glass is frequently marked with soap; and although it might appear at first sight that clean water must thoroughly remove this article, the operator will be certain of spoiling many of his pictures if he depend upon water alone.

The plan which the writer would therefore recommend is as follows. Pour upon the plate a few drops of ammonia and rub it well over both surfaces, and thoroughly rinse through two waters, allowing the water to flow over the plate either by pouring from a vessel or holding under a tap; now with a clean cloth wipe perfectly dry, and free from marks occasioned by a damp cloth, finally well rub with a leather. Simple as this may appear, there is much more in it than will be at first imagined, for without the glass is free from stains it is quite impossible to be successful. The plate may be washed perfectly clean, but the surface not thoroughly dried. Then again some hands are very warm, and if the plate is allowed to rest too much upon any one part, or held too long in the fingers at any one particular spot, that will become warmer than the surrounding part, from the glass being a bad conductor of heat. The cloth and leather should therefore be sufficiently large, that the plate may be as it were insulated as much as possible from the hands, that no unnecessary heat shall be applied. At the same time the employment of a warm cloth is very useful, for the heat is then equally diffused over the plate, and, what is very essential, the surface perfectly and quickly dried. Should the cloth be very warm, it will be necessary to allow the plate to rest before putting on the collodion, or the coating will be too thin, this may be done by standing it on its edge, or placing in a box until ready for use. A dry silk handkerchief has been recommended previous to coating the plate, but the objection to this is, that in dry weather the plate is rendered so very electric that it attracts the very thing it is desirable to avoid, viz., particles of dust floating in the atmosphere.

Having obtained a clean and perfectly dry surface, the next operation is that of—

COATING THE PLATE.

It has already been pointed out how necessary it is to handle the plate as little as possible in cleaning; we therefore suppose the operator to have the plate in a clean dry leather, from which it is taken to receive the collodio-iodide. Now there are different ways by which this may be effected, some preferring a piece of India-rubber fastened to the back as a handle, or supporting it on the ends of the fingers, whilst others content themselves by sacrificing a small portion of one corner; but whichever plan is adopted, the plate must be held by the left hand perfectly horizontal, and then with the right a sufficient quantity of collodio-iodide should be poured into the centre, so as to diffuse itself equally over the surface. This should be done coolly and steadily, allowing it to flow to each corner in succession, taking care that the edges are all well covered. Then gently tilt the plate, that the superfluous fluid may return to the bottle from the opposite corner from which the plate is held. At this moment the plate should be brought into a vertical position, when the diagonal lines caused by the fluid running to the corner will fall one into the other and give a clear flat surface. To do this neatly and effectually, some little practice is necessary as in most things, but the operator should by no means hurry the operation, but do it systematically and quietly, at the same time not being longer over the operation than is actually necessary, for collodion, being an æthereal compound, evaporates very rapidly. Many operators waste their collodion by imagining it is necessary to perform this operation in great haste, but such is not the case, for an even coating can seldom be obtained if the fluid is poured on and off again too rapidly; it is better to do it steadily, and submit to a small loss from evaporation, and at any future time, if the collodion becomes too thick, to thin it with the addition of a little fresh and good æther.

We now come to the next operation—

EXCITING THE PLATE.

Previous to this it is necessary to have the bath ready, which is made as follows:—

Nitrate of silver, 30 grains.
Distilled water, 1 oz.
Dissolve and filter.

The quantity of this fluid *necessary* to be made must depend upon the *form of trough to be used*, whether horizontal or vertical, and also upon the *size* of plate. The kind used by the writer is the vertical, though many still prefer the former, and attach, as before described, a piece of Indian rubber to the back of plate as a handle whilst applying the collodion, and to keep the fingers from the solution whilst dipping in bath. With the vertical troughs a glass dipper is provided upon which the plate rests, preventing the necessity of any handle or the fingers going into the liquid. Having then obtained one or other of these two, and filtered the liquid, previously free from any particles of dust, &c., the plate is to be *immersed steadily and without* HESITATION, for if a pause should be made at any part a line is sure to be formed, which will print in a subsequent part of the process.

The plate being immersed, must be kept there a sufficient time for the liquid to act freely upon the surface, particularly if a negative picture is to be obtained. *As a general rule it will take about two minutes, but this will vary with temperature* *and make of the collodion.* In very cold weather, or indeed anything below 50° Fahrenheit, the bath should be placed in a warm situation, or a proper decomposition is not obtained under a very long time. Above 60° the plate will be certain to have obtained its maximum of sensibility by two minutes' immersion, but below this temperature it is better to give it a little extra time.

To facilitate the action, let the temperature be what it may, the plate must be lifted out of the liquid two or three times, which also assists in getting rid of the æther from its surface, for without this is thoroughly done an uniform coating cannot be obtained; *but on no account should it be removed until the plate has been immersed about half a minute*, or marks are apt to be produced.

Having obtained the desired coating, the plate is then extremely sensitive to white light, and therefore, we presume the operator has taken every precaution to exclude ordinary day-light.

The best way of doing this is to hang over the window two or three thicknesses of yellow calico, by which means the light which passes through will be amply sufficient for manipulation, and at the same time produce no injury to the sensitive plate.

If the foregoing plan cannot be followed, the room must be closed against any portion of day-light, and a candle alone employed, placed at a distance from the operator to give the requisite light.

The plate thus rendered sensitive must then be lifted from the solution and held over the trough, that as much liquid as possible may drain off previously to being placed in frame of camera, and the more effectually this is done the better, or the action in camera will not be equal over the whole surface, at the same time it must not be allowed to dry, but, in short, to obtain its full maximum of sensibility, it should be damp without superfluous moisture.

The question is often asked. how soon after coating the plate with collodio-iodide, should it be immersed in the nitrate bath? Now this is a difficult question to answer. We have said the time *of immersion* is dependent upon temperature and make of collodion, so likewise must we be governed as to time *before immersion.* To make collodio-iodide or xylo-iodide, for, chemically speaking there is no difference in the two, it is necessary that the æther should contain a certain quantity of alcohol, or the different articles are not soluble; therefore, if we take a fresh bottle and coat the plate from this while it contains its full dose of æther, and with the thermometer ranging between 60° and 70°, the evaporation of this article will be very rapid, and consequently a tough film soon formed; but if, on the other hand, we are using an article which has been in use some time, and many plates, perhaps, coated, the proportion of alcohol will be much greater, and not being of so volatile a nature, will necessarily take a longer time to acquire the requisite firmness for immersion. Hence it is evident we must be guided by circumstances. If, for instance, after coating a plate, we find on immersion it does not colour freely, we have then reason to suppose the plate has not been immersed sufficiently quick; but if, on the other hand, we find the film very tender, and upon drying it cracks, then we have reason to know that plates prepared from that bottle must not be immersed quite so soon. *The larger the proportion of alcohol the more tender the film, but the more sensitive will be the plate, and the quicker and more even will be the action of the bath.*

The next question also often asked is, How long must be the exposure in camera? a question more difficult to answer than the last, without knowing something of the working of lens and intensity of light. Practice alone can determine, combined with close observation of those parts which should be the shadows of a picture. If, for instance, in developing we find those parts less exposed to the light than others develop immediately the solution is applied, then we have every reason to suppose the exposure has been too long; but if, on the contrary, they develop very slowly, we have proof the time allowed has not been sufficient to produce the necessary amount of action. In a good picture we should see first the whites of a dress appear, then the forehead, after which we shall find, if the light has been pretty equally diffused, the whole of the face and then the dress.

Much will, of course, depend upon the arrangement of light, for if the sitter is not placed in a good aspect, by which is meant a good diffused light, the prominent parts only will come out; or, to produce the necessary amount of action to obtain the others, the high lights are so overdone that the picture prints raw and cold.

Can I produce portraits at my drawing room window? This is another common question, and the reply must necessarily be, Yes, if you have sufficient light, and can so place your camera that the sitter may be pretty equally illuminated and not one half receiving nearly all the light; if it does, one side may be amply done and the other scarcely visible.

In cases of this description the necessary effect may often be produced by placing a white screen so as to reflect a portion of light upon the darkened side; but, upon the whole, a light of this character is better adapted for producing positive than negative pictures upon glass.

We must now suppose the plate to have received its necessary impress in camera; and proceed to—

THE DEVELOPMENT OF IMAGE.

To effect this it must be taken again into the room where prepared, and with care removed from the slide to the levelling stand. It will be well also to caution the operator respecting the removal of plate. Glass, as before observed, is a bad conductor of heat; therefore if, in taking it out, we allow it to rest on the fingers at any one spot too long, that portion will be warmed through to the face, and as this is not done until the developing solution is ready to go over, the action will be more energetic at those parts than at others, and consequently destroy the evenness of the picture. We should, therefore, handle the plate with care, more as if it already possessed too much heat to be comfortable to the fingers, and we must therefore get it on the stand as soon as possible.

Having then got it there, we must next cover the face with the developing solution.

This should be made as follows:—

Pyrogallic acid	5 grains.
Distilled water	10 oz.
Glacial acetic acid	40 minims.

Dissolve and filter.

Now, in developing a plate, the quantity of liquid taken must be in proportion to its size. A plate measuring 5 inches by 4 will require half an ounce, less may be used, but it is at the risk of stains; therefore we would recommend, that half an ounce of the above be measured out into *a perfectly clean measure*, and to this from 8 to 12 drops of a 50-grain solution of nitrate of silver added.

Pour this quickly over the surface, taking care not to hold the measure too high, and not to pour all at one spot, but having taken the measure properly in the fingers, begin at one end, and carry the hand forward; immediately blow upon the face of plate, which has the effect, not only of diffusing it over the surface, but causing the solution to combine more equally with the damp surface of the plate; it also has the effect of keeping any deposit that may form in motion, which, if allowed to settle, causes the picture to come out mottled. A piece of white paper may now be held under the plate, to observe the development of the picture; if the light of the room is adapted for viewing it in this manner, well; if not, a light must be held below; but in either case arrangements should be made to view the plate easily whilst under this operation, a successful result depending so much upon obtaining sufficient development without carrying it too far.

The author has also found a weak developing solution, as given above, far more successful in obtaining gradation of tone than when stronger, for, in the latter case, the action will be very energetic on those parts reflecting the most light, and, consequently, become overdone before other portions, such as dress, &c., have become sufficiently visible. The addition of an extra portion of nitrate of silver will be found to improve the tone, but this may be effected also without adding it to the pyrogallic solution; and, in many instances, will be found a better plan, viz., to re-dip the plate in haste, after exposure in camera, particularly if any considerable time has elapsed between the excitement of plate and development of picture, for the plate having dried unequally, does not allow the same uniform development as when well moistened over the surface.

As soon as the necessary development has been obtained, the liquid must be poured off, and the surface washed with a little water, which is easily done by holding the plate over a dish and pouring water on it, taking care, both in this and a subsequent part of the process, to hold the plate horizontally, and not vertically, so as to prevent the coating being torn by the force and weight of the water.

This being done we arrive at the—

FIXING OF IMAGE,

Which is simply the removal of iodide from the surface of plate, and is effected by pouring over it, after the water, a solution of hyposulphite of soda, made of the strength of 4 oz. to a pint of water. At this point day-light may be admitted into the room; and, indeed, we cannot judge well of its removal without it. We then see, by tilting the plate to and fro, the iodide gradually dissolve away, and the different parts left, more or less, transparent, according to the action of light upon them.

It then only remains to thoroughly wash away every trace of hyposulphite, for, should any of this salt be left, it gradually destroys the picture. The plate should, therefore, either be immersed with great care, in a vessel of clean water, or, what is better, water poured gently and carefully over the surface.

After this it must be stood up to dry or held before a fire.

It may be as well to state, any clean filtered water will answer for washing, distilled being only required for the solutions of nitrate of silver, &c.

We have now carried the operator carefully through every stage of the process, from the cleaning of plate to the fixing of image; but our remarks have reference to collodio-iodide alone, that is, gun-cotton dissolved in alcoholized æther, charged with an iodide of silver. We cannot, however, consider our task finished, without mentioning the addition of gutta percha to the collodion. This valuable discovery was made by P. W. Fry, Esq., to whom the public are more indebted for this process than many are aware of. Although not the inventor of collodion as a photographic agent, which discovery is due to Mr. Archer, yet to Mr. Fry belongs the credit of having, with his indefatigable zeal and perseverance, taken it up when the inventor had thrown it aside, and, notwithstanding the objections of many, carried it up to its present state of perfection.

In that portion of these directions relating to the excitement of plate, we have stated that the larger the proportion of spirit the more tender the film, *but the more sensitive the plate.* Now the addition of any article which will improve the film must be truly valuable, and this is obtained by the addition of gutta percha, which allows us to use a larger proportion both of iodide and spirit, and, therefore, in two ways to obtain an increase of sensibility.

To such an extent as this been carried by Mr. Fry, that pictures have been taken in an inappreciable time and by artificial light. For instance, plates have been prepared, negative pictures placed in contact with the prepared surface, and for an instant exposed to the light of an argand burner, and this, with the assistance of a developing agent, has been found sufficient to produce a strong positive picture. So also has the discharge of a single Leyden jar at the Royal Institution,—an experiment conducted by Mr. Fry, and witnessed by Sir W. Snow Harris, Professor Farraday, &c., &c.*

The plan of proceeding to obtain this extreme sensibility, as recommended by Mr. Fry, is to obtain a thick and strongly charged collodio-iodide, and to two parts of this add one of a saturated æthereal solution of gutta percha, allowing it to stand a day or two to clear itself previous to being used.

The plate is then coated in the usual manner. As the æther evaporates a peculiar white film comes over, at which time it is ready for immersion in the bath. This must be conducted as previously described, and, from its extreme sensibility, with, if possible, greater precaution than before.

For the development of negative pictures, Mr. Fry recommends the pyrogallic solution, rather stronger than that previously given, about one grain to the ounce, with the addition of an extra portion of acetic acid, and the plate *re-dipped in the nitrate bath*, in preference to adding silver solution to the pyrogallic.

In fixing the image after development it is necessary to keep the hyposulphite on longer than with ordinary collodion, as the iodide is held with greater tenacity. In other respects, the method of proceeding is precisely the same.

Having, by the foregoing means, obtained and fixed a negative photographic image on glass, and which is capable of producing positives upon paper by the ordinary photogenic means; it is as well, previous to obtaining these, to render the tender film of collodion less liable to injury.

* A picture, produced by these experiments, has been kindly given the writer by Mr. Fry, and the curious may see it at 121, Newgate Street.

This can be accomplished by means of a varnish, of which there are different kinds that may be used.

The two best are, perhaps, mastic and gum Dammer varnish. The latter, not only dries quickly, but retains its colour without changing yellow. It is a varnish but comparatively little known, though extensively used for varnishing paper from the before-mentioned circumstance. It must not be used too thick, or it will be some days before the picture can be printed. The plan which the writer has been in the habit of adopting, has been to take varnish of the ordinary consistence, and thin it very considerably with turpentine or camphine. Then holding the plate by one corner, pour the varnish on in precisely the same manner as collodio-iodide, returning what is superfluous to the bottle. It should then be made warm, to run off as much as possible, and stood by in a place free from dust, that the surface may become dry and hard.

There is another and much more expeditious method of varnishing than the above, which was suggested to the writer by that eminent photographer, S. Buckle, Esq. It requires care, but is quickly done; is very effectual, and the plate may be printed from it in the course of a few minutes.

Take the ordinary pale spirit lacker, and having made the plate warm either by a lamp or before the fire, pour this over the collodion film in the same manner as before described. Continue the warmth to the plate, but in such a manner that the spirit cannot catch fire, when the whole will be driven off, leaving a hard dry surface. In using this it is necessary to see first, that the plate is warm enough to prevent the gums from chilling, and secondly, that it is not too hot, or the liquid will not run freely. When properly and effectually done, it is difficult, at a first glance, to distinguish the plain surface of the glass from its varnished side.

ON THE PRODUCTION OF POSITIVE PICTURES UPON GLASS.

Hitherto we have described the method of producing negative pictures only, but then by slightly varying the process in developing the collodion pictures, most beautiful positives may be obtained that equal daguerreotypes, and without their metallic reflection. These pictures are strictly positive, for when held to the light they scarcely show as a negative. To produce these positives a much shorter time is necessary for a sitting than for the production of a printing negative. They also require a modification in the development, that as bright a surface may be obtained as possible.

It was shown by the author, in the early days of collodion, that this result might be obtained to a certain extent by mixing with the pyrogallic solution a very small quantity of nitric acid; but it has since been shown by Mr. Fry and others, that a better result may be obtained by the use of proto-sulphate and proto-nitrate of iron.

The former salt is readily obtained, and in a very pure form. It should be used as follows:—

Proto-sulphate of iron, 10 grains.
Distilled water, 1 oz.
Nitric acid, 2 drops.

To develop the image pour the above over the plate, taking care not to carry the development too far.

The proto-nitrate may be obtained either by double decomposition, as recommended by Dr. Dymond, or by dissolving sulphuret of iron in dilute nitric acid, as recommended by Mr. Ellis. The latter, being the most economical, we will describe first

To one ounce of nitric acid and seven of water, add a small quantity of sulphuret of iron broken into fragments. Stand the vessel aside, that the sulphuretted hydrogen may escape, and the acid become saturated with iron. Pour off the liquid and filter. Then boil in a Florence flask to get rid of the sulphur, and again filter, when a dark green liquid will be obtained, which is the proto-nitrate of iron. This should be kept in well-stoppered bottles, and from the air as much as possible, to prevent its changing into a per-nitrate, in which stage it is quite useless as a photographic agent.

To develop the picture, mix one part of the above proto-nitrate with three of water, and apply it to the plate in the ordinary way, when a most beautiful clear image will be obtained.

Dr. Dymond's method we take from the Art Journal. 600 grains of proto-sulphate of iron are dissolved in one ounce of water, and the same quantity of nitrate of baryta in six ounces of water; these being mixed together, proto-nitrate of iron and sulphate of baryta are formed by double decomposition.

The negative image being developed, a mixture of pyro-gallic and hypo-sulphite of soda, which has undergone partial decomposition, is poured over the plate, which is gently warmed. Upon this the darkened parts are rendered brilliantly white by the formation of metallic silver. This picture being backed up with black velvet, assumes the air of a fine daguerreotype without any of the disadvantages arising from the reflection of light, from the polished silver surface. We have also seen a similar effect produced by Mr. Fry and Mr. Berger, by the use of the proto-sulphate of iron solution, as given at page 75, and pyrogallic acid. The image is first developed by the iron solution, which is then poured off, and another solution of pyrogallic is poured on, until the effect is produced.

The pictures are fixed with the hyposulphite in the usual method.

By the expression, *Printing of Glass Negatives*, is meant the formation of positive images upon paper. Now this, at first sight, appears very easy, and, though theoretically simple, it requires considerable attention to do it properly. Judgment is also necessary, for no two pictures scarcely will bear just the same treatment, from the fact that it is almost impossible to develop two alike in this uncertain climate. Could we always command the same amount of light, the task of taking negatives by the camera, and printing positives from them, would be much simplified, but the light varying so frequently makes it much more uncertain as to the result.

The plan of proceeding most generally adopted is to coat a sheet of paper with a solution of a muriate of some kind, either that of soda, baryta, or ammonia, and afterwards drying. Now this may be done either by immersion in a weak solution, or by taking a stronger one and brushing it over one side only, or placing the solution in a flat dish, and with care floating each sheet for a few minutes upon it until it lies flat upon the surface, in each case taking the precaution to mark the prepared side. Any number of sheets may be prepared in this manner and kept ready for use, and if the proportion of salt used to each ounce of water is marked on one corner, we know at any future time how to excite with the silver solution.

Very excellent results may be obtained by the following solution:—

Muriate of ammonia, half a grain.
Water, one ounce. Dissolve.

This being very weak, the paper must be wholly immersed; we should therefore place the solution in a flat dish, and immerse ten or twelve sheets one after the other, taking care to avoid all air bubbles which should be removed with a clean camel's hair brush; allow them to soak a few minutes, according to thickness of paper, and then turn the whole and begin taking out the first immersed and pin up to dry.

To excite paper prepared as above, a solution of ammonio-nitrate of silver, containing thirty grains of nitrate of silver to the ounce, is the best strength. This should be applied freely to one side with a camel's hair brush, *until the surface is well and evenly wetted over*. They should then be allowed to dry either in the dark, or, which is better, held at a short distance from a fire.

Pictures printed upon paper prepared as above are of a brownish tint, the colour varying more or less with the paper used.

Another very excellent paper may be prepared as follows:—

Muriate of ammonia, ten grains.
Water, one ounce. Dissolve.

Coat one side only of a sheet with this, and dry. Then apply a plain solution of nitrate of silver, sixty grains to one ounce of distilled water, in the same manner as before described.

These two last solutions are well adapted for Canson's paper, and also the following:—

Muriate of ammonia, five grains.
Water, one ounce. Dissolve.

Coat the paper as above, and when dry excite with a sixty-grain solution of ammoniacal nitrate of silver.

For richness of tone nothing perhaps can surpass the two latter solutions, but it must also be borne in mind that to obtain good positives we must first see that our negatives are good, and not expect good results when the latter are not capable of giving them.

The method of printing being precisely the same as for paper negatives, and so fully described in a previous part of this work, needs not be again repeated.

To fix the pictures prepare the following solution:—

Hyposulphite of soda, two ounces.
Water, one pint.
Nitrate of silver, thirty grains.

Mix these well together, and allow the solution to stand and clear. Then pour the clear solution into a dish and immerse the picture, allowing it to soak until the solution has penetrated every portion of the paper, which will take from ten to twenty minutes, and sometimes more if the paper is very thick and old, after which remove to a vessel of cold water, where it should be allowed to soak some time. The cold water should then be poured off and hot water poured on, to remove every portion of size from the paper, for without the latter is entirely taken out the picture is not *properly fixed.* This should be repeated again and allowed to cool, when the picture may be taken out and dried.

The tone of the picture is also still further improved by placing in a semi-dry state between blotting paper, and passing a hot iron over them.

PHOTOGRAPHY ON WAXED PAPER.

BY GUSTAVE LE GRAY.

(Translated from the French.)

PRELIMINARY PREPARATION OF NEGATIVE PAPER FOR OPERATING BY THE DRY PROCESS.

This preparation has for its aim the completely stopping up, by means of white or virgin wax, all the pores of the paper, and thus rendering it more capable of receiving an equal action under the influence of the different operations.

The paper also assumes the appearance and firmness of parchment, and after the picture is obtained it has the advantage of not requiring to be again waxed, in order to obtain the positive proof.

§ 5. The following is the method of performing this operation.—Having obtained a large silvered plate, similar to that employed for the daguerreotype, you place it horizontally upon a tripod stand over a spirit-lamp, or, which is better still, over a water-bath; at the same time, with the other hand, you rub its upper surface with a piece of white wax, which becomes melted.

When you have obtained a fine and equal bed of melted wax, the sheet of paper is laid upon it, and its perfect adherence facilitated by means of a card.

When the wax is equally imbibed by the paper, it is taken off the plate, and placed between some sheets of smooth bibulous paper, over which you pass a moderately hot iron to remove the excess of wax. It is very essential that the wax should be entirely removed from the surface, and that it remain only on the texture of the paper. A sheet well prepared should not have any shining points on its surface when viewed in the light, and should be equally transparent.

The iron is sufficiently hot when a drop of saliva, let fall on its surface, very quickly evaporates without running off its surface. If hotter, it spoils the wax and stains the paper.

Very thin paper is to be preferred for the preparation: that of Lacroix and Canson Frères, of fourteen to seventeen pounds the ream, is very good.

§ 6. One of the principal qualities of paper thus prepared, besides its great transparency, allowing the smallest bubble of air remaining on the surface during the various preparations being perceived easily, is that it permits the proof to be left in the gallic acid to develop during a very considerable time without spoiling the proof. I have left some proofs for three entire days in the acid without being in the least soiled. But its principal quality is that it can be prepared with the aceto-nitrate of silver some time before being required for use, and thus being able to operate with dry paper, which will keep good and sensitive for several days.

This preparation also gives more intense darks upon thin paper than have hitherto been obtained by other means.

The bath of iodide of potassium completely penetrates the wax, and its greasy aspect is removed by a sort of decomposition, which makes all the subsequent preparations capable of being very equally applied. It is necessary to have the paper from a half to one hour in the bath of iodide, according to the thickness of the paper, before the wax will be sufficiently decomposed. The thicker the paper, the greater length of time is required.

Care must also be taken, when the paper is dry, not to expose it to any heat before being placed in the bath of nitrate of silver, otherwise the surface becomes greasy, and prevents the bath of silver being equally applied.

After the paper has been exposed to the iodide of potassium, it assumes a violet tint when completely dry. This tint, which is produced by a combination of the iodide with the wax, far from being any prejudice, is, on the contrary, very useful, because it indicates the time the paper should be left in the aceto-nitrate of silver; the time is just that required to remove this violet tint.

FIRST OPERATION.

Preparation of Negative Paper.

§ 7. Place, in a vessel of porcelain or earthenware, about eight ounces of rice, six and a half pints of distilled water, and gently boil. The particles of rice should only be allowed to slightly break, in order that the liquor obtained should not be rendered thick by an excess of starch, but contain only the glutinous part of the rice. Strain the whole through a piece of fine linen, and preserve the water that comes through. It is an excellent wash, which gives a body to paper, and produces very beautiful blacks.

§ 8. To prepare the first bath in which the paper is to be soaked, you must include those salts which form a sensible preparation under the re-action of the aceto-nitrate of silver; you make a solution in forty-two ounces of the foregoing rice-water of the following substances:—

Sugar of milk . .	617	grains.
Iodide of potassium .	231	,,
Cyanide of potassium .	$12\frac{1}{2}$	,,
Fluoride of potassium .	8	,,

When the whole of these substances are perfectly dissolved, filter through a piece of fine linen, and receive it in a bottle in which it can be kept till required for use. This preparation can be kept a considerable time without decomposition.

When you wish to prepare some paper, pour this solution into a large dish, and completely immerse your waxed paper, sheet by sheet, and one above the other, taking care to remove any air-bubbles that may be produced.

From fifteen to twenty sheets may be prepared at a time, and they may be left to soak from half to one hour, according to the thickness of the paper.

Turn over the whole mass so as to commence at the first sheet immersed, and hang them up to dry by pinning them by the corner to a string stretched horizontally in the air. Afterwards apply to the lower corner of each sheet a piece of blotting paper, which will easily adhere and facilitate the removal of the superfluous liquid.

French and English paper should not be placed together in the same vessel, it is better to prepare them separately.

English paper contains a free acid which immediately causes a precipitate of iodide of starch on the French paper, and gives it a deep violet tint.

When the paper is dry, cut it to the size of your camera and keep it in a portfolio for use.

This paper being almost insensible to light, may be prepared in the day. At the same time it should not be exposed too long to a bright light, which decomposes the iodide of potassium and precipitates iodine upon the starch on the paper.

The liquid that remains after removing the paper may be poured into a bottle, and will serve to prepare other paper until it is exhausted. It only requires to be filtered just before being used.

For the sake of brevity I call paper subjected to the preliminary preparations simply *iodized paper*.

SECOND OPERATION.

Method of rendering sensitive.

Make, in a darkened chamber and by the light of a candle only, the following solution in a stopped glass bottle :—

§ 10. Distilled water, 150 grains.
Crystallized nitrate of silver, 5 grains.
When the nitrate of silver is dissolved, add
Crystallizable acetic acid, 12 grains.

This solution should be kept from the light by surrounding the bottle with black paper.

This proportion is excellent for papers which are to be employed a considerable time after preparation, but if the paper is required to be more sensitive, to be employed dry and not to be kept more than four days, it will be better to employ the following proportions:—

§ 11. Distilled water, 150 grains.
Nitrate of silver, 10 grains.
Glacial acetic acid, 12 grains.

The following is the mode of proceeding; you take two shallow vessels of *porcelain*, into the first you put the aceto-nitrate of silver (§ 11), to the depth of about two-tenths of an inch, and into the second you pour some distilled water.

You immerse the iodized and waxed paper (§ 5 and 8) completely into the bath of aceto-nitrate of silver, and allow it to remain from four to five minutes; you then remove it immediately into the bath of distilled water, where you leave it at least four minutes, and longer if you wish to keep the papers some considerable time before being employed. You can thus prepare in the same bath about ten sheets of paper one after the other. When the paper is removed from the water it is to be dried betwen some folds of smooth and fresh bibulous paper, and kept for use in a paper case of the same material, which must also be new. This paper should not be dried by suspending it in the air, otherwise it will become quite black in the gallic acid, it is better to let it dry naturally (as one might say) in a blotting case, placing alternately a sheet of the prepared and a sheet of bibulous paper.

If paper thus prepared is kept from the action of light, it will retain its sensibility from five to six days and even more. If prepared with the aceto-nitrate, indicated at § 10, it will keep perfectly well ten or twelve days, but it is less sensitive.

This mode of operating is extremely valuable for travelling, as it avoids those manipulations which are so difficult when away from home. All that is required to be carried, besides the camera and backs containing prepared paper, is a portfolio capable of being well closed and containing two compartments; in one is placed the stock of prepared paper in reserve, and in the other the sheets that have been exposed in the camera.

However short the time of exposure in the camera the light will have produced its impression, and we should always be enabled to get a good picture by leaving the proof a proportionate time in the bath of gallic acid. I am of opinion that the image is formed immediately the luminous rays, refracted by the lens, strike the sensitive paper.

Thus, for example, I took two views of the same object and at the same time. One of these was exposed 20 seconds and the other 15 minutes, the result was the same; only the former did not come out until it had remained a day and night in the gallic acid, whereas the latter was completely developed in an hour.

The dirty and stained appearance which this paper assumes while in the gallic acid and when dry, is of no consequence: this appearance entirely disappears and does not affect its transparency, after the wax contained in the proof has been melted by exposing the negative to a moderate heat. This precaution should never be neglected, it is indispensable to the perfection of the proof, and is superior to a new waxing.

A fresh quantity of aceto-nitrate must be employed for preparing each parcel of papers; after being used it may be poured into a bottle and precipitated by some chloride of sodium, the chloride of silver formed can be used for any required purpose.

THIRD OPERATION.

Exposure in the Camera.

For a portrait in the shade with a double combination of lenses, about 3 inches in diameter, and with my dry waxed paper, I give from 15 seconds to one minute.

For views with a single achromatic and a stop about $\frac{3}{4}$ inch in diameter, the exposure should be from 30 seconds to 20 minutes in the sun, according to the brightness of the season. The time should also vary according to the colour of the objects wished to be copied; for example, with an equal light a monument will require 30 seconds' exposure, whereas it will require 20 minutes to produce the trees of the forest.

Heat is also a great cause of accelerated action. Thus, if the case containing the prepared paper is warmed, the operation is quickened, but then the lens must be warmed to an equal degree, otherwise a deposition of moisture takes place and prevents the formation of an image.

The exposure in the camera being finished, very little if any of the image will be seen until it is developed by the following operation, which may be deferred if necessary for a day or two without injury.

FOUTH OPERATION.

Development of the Image.

§ 16. The latent image is developed by means of a solution of gallic acid in distilled water, the proportion I find the best is the following —

Distilled water, 42 ounces.
Gallic acid, 60 grains.

Pour this solution into a shallow basin to the depth of about a fifth of an inch, and completely immerse the proof, taking care that there are no bubbles of air.

According to its development, which is easily perceived through the thickness of the paper, it must be left in the bath from ten minutes to one hour, or more, until it arrives at its perfection, which in some instances may be a day or two, according to the time exposed in the camera. This process can be singularly accelerated by adding a few drops of aceto-nitrate of silver (15 to 20) when the image begins to develop itself, and very intense blacks are obtained by this method; but care must be taken to watch the action, because, being so rapid, you run the risk of getting the blacks too decided if left in too long a time.

When the proof is well developed, remove quickly and place it in another vessel and wash with several waters, lightly rubbing the back with the finger to remove the crystalline deposit which might cause stains.

The tone which the picture assumes under the action of the gallic acid indicates if the time of exposure has been correct.

If the proof has a blackish grey appearance all over, it has been exposed too long; if the high lights which ought to be the blackest parts of the negative are not deeper than the half-tints, the exposure has still been too long. If the time of exposure, on the contrary, has been too short, the lights will be but feebly defined. If the time has been correct a superb proof will be obtained, having the lights and shades well defined and transparent.

This operation can be accelerated in cold weather by slightly warming the gallic acid.

The picture thus obtained is not permanent. It must be rendered so by the following operation, having first washed it in water.

FIFTH OPERATION.

Fixing the Negative Proof.

§ 17. Make, in a bottle, the following solution:—

Filtered water, one pint.
Hyposulphite soda, two ounces.

Put of this solution about one fifth of an inch in depth at the bottom of a vessel, and plunge complete the negative proof, taking care to avoid air-bubbles.

One proof only at a time should be put in the bath; it will nevertheless serve for several proofs, one after the other.

The solution of hyposulphite which has been used is poured into another bottle and allowed to remain quiescent for some time, when a precipitate of gallate and sulphuret of silver will be formed, it is then filtered and forms an excellent solution for fixing feeble proofs.

The proof should be left in the bath of hyposulphite until the yellow tint of the iodide of silver is removed; it should not be left too long, otherwise the blacks of the picture suffer; from 10 to15 minutes is usually sufficient.

The negative when removed from the hyposulphite should be washed in several waters, and afterwards left in a large vessel of water for about half an hour, so as to remove the whole of the hyposulphite.

The proof is now completely fixed and unalterable by light, and may be suspended by one corner in the air to dry.

SIXTH OPERATION.

Waxing the Negative Proof.

This is done by holding the proof before a moderate fire, so as to give to the wax that transparency which it has lost by the successive baths; before this process they have a soiled appearance, which is of no consequence as they disappear by this operation, as I have before mentioned."

For the following observations and modification of M. Le Gray's process I am indebted to R. Fenton, Esq., who has been most successful in his results by the employment of waxed paper, and whose remarks cannot fail to be of great value to those intending to practise this particular process.

PHOTOGRAPHY ON WAXED PAPER,

BY R. FENTON, ESQ.

In noting down the observations which I have made with respect to the manipulation of the waxed paper, I will take the work of Le Gray as a text-book, and follow the order of its arrangement.

As a practical guide it is intelligible and simple, and is only faulty where the author ventures upon chemical theories.

And to begin first of all with the choice of the paper.

This preliminary is not quite so important here as in the ordinary Talbotype method, but nevertheless the beauty of the results depends much upon a judicious selection of this material.

The qualities that should be united in a good paper are firmness and evenness of texture, smoothness of surface, and a sizing that shall not be injurious to photographic action, nor so dense as to be impermeable to the melted wax. Whatman's and Turner's photographic paper possesses the first of these qualities.

They are especially remarkable for their evenness, but are sized so strongly with gelatine that the wax is with great difficulty made to penetrate them. A second objection to them is the nature of the size, gelatine acting as a check upon the photographic action.

Paper made by Whatman from the year 1832 to 1838 is said to be much better adaped to the purpose. It was thinner then than present make, and much less highly sized. It is much used by the French, who say that it gives better half-tones, and supports the action of the gallic acid for a longer time than their own papers. I have not made a sufficient trial of it, but am inclined to think that from the greater length of time during which it must be exposed to the action of light in order to obtain a vigorous picture, that it is better suited to the more brilliant atmosphere of France than it would be to our own.

The paper that I have found to answer the best is certainly the thin Canson, weighing about 14 lbs. to the ream. It is subject to many defects, being very unequal in thickness, full of specks, and often sprinkled with iron spots, which are fatal to the beauty of the negative picture. They may be always detected by their rusty colour and a reddish aureole round them. It is, so to speak, very sensitive to the action of light, being sized almost entirely with starch. On one side it is tolerably smooth; and owing to the fact that the rags from which it is made are not ground to so fine a pulp as in the English mills, it is more tenacious than the Whatman paper.

The Lacroix paper is of similar quality, more free from iron spots, but not so even in texture.

There are other papers which I am now trying.

A much better may be made than any which we now possess; and I am glad to say that, owing to the exertions of Mr. Sandford, it is likely that the wanted medium will soon be supplied.

To take then the Canson paper, it must be chosen clean, free from spots, and of a creamy colour; the greater portion of that which comes to the English market is of a colder tone, and is generally of an inferior character.

When chosen the sheet must be marked upon the wrong side with any mark (such as the initials of the operator), which will show by its shape upon which side of the paper it is placed.

It will require a little practice to find out the wrong side of the paper. It is that on which the web is most distinct, and it is most easily distinguished in a raking light.

It should be cut a little larger than the required picture.

We now proceed to the waxing, which is rather a tedious operation, but one upon which a successful result mainly depends.

To do this I employ a flat tinned copper dish, about half an inch deep, fitting into the top of a second zinc dish, into which I pour hot water.

This water is kept at the boiling point by means of a heater in the centre, or by a lamp placed underneath.

A sufficient quantity (two or three cakes of the best white wax) is allowed to melt in the upper dish, and each sheet is laid in succession upon the surface, a second being laid down when the first is taken off, and held up till all the superfluous wax that can drop back into the dish has done so.

The French paper becomes saturated instantly. English paper takes some minutes, and must be left until the wax has penetrated through all the fibre.

When a sufficient quantity of paper has been thus prepared, each sheet should be held up in turn in front of a pretty hot fire, to melt off into a pan beneath as much as possible of the excess of wax. The remaining excess must be ironed out. To do this place the sheet on blotting paper, face downwards, and keep at least two pieces of blotting paper between the iron heater and the waxed sheet. It must be ironed until, on looking along the surface of the paper, no shining patches indicate the presence of too much wax, and until on looking though it the transparency of the sheet shall be equal throughout.

One sheet waxed in the way described may, to prevent the waste of material otherwise inevitable, be employed to wax a second piece; but the excess of wax from the first must be driven out into the fresh paper by an iron as hot as can be used without injury, or else the pores will not be completely filled up, and the negative made from such paper will be of an inferior character.

For iodizing the paper I have employed several methods, commencing with the formula given in Le Grey's work.

Every preparation that I have tried has given some good pictures.

They vary in intensity, in transparency, and in rapidity of development; but as there are so many causes which affect the chemical action of the rays of light, we must not assign without considerable caution any difference of result to a difference of preparation.

Le Gray's vehicle, to use an artist's phrase, is rice-water, which he recommends on account of the starch which it holds in solution. It may be used with advantage in the preparation of English paper, but the French contains in its own substance a sufficient quantity of that material.

If the rice be too much boiled, the resulting liquid is charged with the coarser particles of the starch, and the paper steeped in it will produce negatives with very black but speckled skies, and rough half-tones without gradations.

If it be boiled as it ought to be for only a minute or two, the liquid will still let fall a considerable precipitate, from which it must be filtered through fine muslin before being used. As the water reaches the boiling point, the vesicles of starch contained in the rice expand and burst, the contents become dissolved, and the shells, at first held in suspension, gradually descend.

The proportion of iodide of potassium recommended by M. Le Gray, I believe to be too small a quantity for producing successful results under an English sun. The following formula, given me by M. Pulch of Paris, I have used with considerable success:—

Distilled water . .	35	ounces by measure.
Iodide of potassium .	246	grains.
Bromide of do. .	15	,,
Cyanide of do. .	15	,,
Fluoride of do. .	$7\frac{1}{2}$	,,
White honey . .	154	,,
Sugar of milk . .	231	,,
The white of one egg.		

The paper so prepared is considerably more sensitive than the first. It will not, however, keep uninjured when made sensitive for more than three days in summer, or a week in winter, nor will it bear a very prolonged action of the gallic acid.

A preparation used by Vicomte Vigies, one of the most successful and indefatigable of the French photographers, is as follows:—

35 ounces, by measure, of whey which has been boiled, with the whites of two eggs to clarify it, and filtered.
385 grains of iodide of potassium.
61 ,, of bromide do.
30 ,, of cyanide do.
23 ,, of fluoride do.

This paper has several advantages:—it will, when excited, keep uninjured, if protected from the light and air, for a very long time. The Vicomte assures me that one of the best pictures he ever made was taken on paper that had been excited two months previously. This was in the winter. I have never tried how long it would remain serviceable, but have constantly found it perfectly good after a week's keeping, during the very hot weather we have had in June and July last. The parts unacted upon by the light are, owing to the large proportion of bromide, preserved beautifully clear and transparent. It has, however, a great defect. It is a very slow paper, suitable only for hot weather and powerful light.

Generally wax paper requires a longer exposure in the camera for the production of a good picture than that prepared according to Mr. Talbot's method, or with the double iodide of potassium and silver.

This, however, may, I think, be explained, and at the same time remedied.

In looking over all that has been written on the preparation of iodized paper, it is very seldom that one finds any reasons assigned for the adoption of this or that formula.

It is a dangerous thing to give reasons; nevertheless we shall not make much real progress until every one who writes upon this subject will venture to state, without thinking what the result may be to his own reputation, the grounds upon which he adopts one plan in preference to another.

Having no more chemical knowledge than can be picked up from elementary works, and being, therefore, in no fear of injuring a chemical character, I will state on what grounds I have adopted the following iodizing mixture.

Of all the methods of iodizing, that of washing the paper with what is called the double iodide, and then by immersion in water, dissolving out the iodide of potassium, and precipitating on the paper a coating of iodide of silver, appears to be the simplest and best. If well prepared, it needs only the addition of a simple excess of nitrate of silver, the degree of which the operator regulates at pleasure to render it sensitive.

I have tried to adapt this mode to the wax-paper, using baths instead of washes, but unsuccessfully as yet. Experience has shown that what is called a twenty-grain paper, i. e. twenty grains of iodide of silver to the ounce of water, is the most generally serviceable.

To form iodide of silver, requires about equal weights of iodide of potassium and of nitrate of silver.

Instead of using iodide of potassium alone, I replace a part of it by chloride of sodium, on account of the greater intensity it gives to the blacks; by cyanide of potassium, because it seems to assist the other salts in penetrating the wax; and by fluoride of potassium, on account of the increase of rapidity which the French photographers attribute to it.

These are the preparations I have adopted:—

Distilled water, or rice water .	35	oz. by measure.
Iodide of potassium . .	617	grains.
Chloride of soda . . .	46	,,
Cyanide of potassium . .	30	,,
Fluoride of potassium . .	15	,,
Sugar of milk . . .	617	,,
White honey	77	,,
Two whites of eggs.		

I believe that the addition of honey increases the rapidity, while the albumen gives increased glossiness to the surface of the paper, at the expense, however, of a little time.

About the use of the cyanide and fluoride, I do not feel quite assured. I have used them on the faith of the experience of French writers, and have not had yet time to make sufficiently careful comparative experiments on this point.

The proportion of chloride of sodium cannot be much increased, as it has a tendency to turn the paper black, if the time of immersion in the bath of gallic acid be at all prolonged.

The iodide of ammonia may be used in place of the iodide of potassium, and, from its being more easily decomposed, produces a more rapid paper; the little experience that I have had of its properties does not, however, induce me as yet to prefer it.

A sufficient quantity of this mixture must be poured into a flat dish, so as to cover the bottom to the depth of a quarter of an inch or more, according to the number of sheets which it is intended to iodize.

Each sheet in succession must be laid upon the surface of the bath, and directly turned over so as to immerse it in the liquid.

Any bubbles that may be underneath must be chased out by means of a hog's hair brush kept for the purpose.

As many sheets may be immersed as the liquid will cover.

After half an hour's immersion, or rather more if English paper be used, the paper is to be taken out sheet by sheet, and pinned up by one corner to a piece of tape stretched across the room. The pins employed must be reserved for this purpose alone; and great care must be taken that the fingers are quite clean, and especially that they are free from the least suspicion of hyposulphite.

When dry they may be placed one upon another in a drawer, and will keep good for an indefinite period. The sheets first prepared in an unused bath do not change colour; after a time iodine becomes disengaged in the solution, and gives both to it and the paper a reddish tone.

To excite the iodized paper, I employ Le Gray's recipe, diminishing only the quantity of acetic acid when the paper is for immediate use. It is sufficiently supplied with nitrate of silver to excite the paper prepared according to the last formula; nevertheless, in order that all the sheets of paper successively rendered sensitive in the same bath may be placed in a uniform condition by the same length of immersion, it is advisable, if there is much paper to be excited, either to increase the quantity or strength of the solution.

I lay the paper upon the bath of aceto-nitrate with the side on which the picture is to be impressed downwards, and turn it over as quickly as possible, that it may be directly covered with the solution. The bubbles must be driven out with a brush kept for the purpose. After an immersion of from three to five minutes, the sheet must be taken out and immersed in distilled water, and shaken about in it, so that most of the excess of aceto-nitrate may be re-dissolved. If it is wished that it should retain its sensitiveness uninjured for any length of time, then the washing must be repeated.

The paper is now dried between some folds of blotting paper, and preserved for use between some clean sheets of the same as recommended by M. le Gray, whose method I adopt for the remainder of the process.

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